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A STUDY OF POLLUTION—AIR

A STAFF REPORT

TO THE

COMMITTEE ON PUBLIC WORKS
UNITED STATES SENATE

SEPTEMBER 1963

Printed for use of the Committee on Public Works

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PREFACE

With the outbreaks of sickness and death associated with air pollution, and attributed to the pollution in some instances, our scientists became concerned that air contaminants could cause harm to man. The deaths of many people in the Meuse Valley of Belgium in December 1930; the illness and deaths of many people in the city of Donora, Pa., in October 1948; the illness and deaths in London in December 1952, and again in December 1962, which were ascribed to air pollution, dramatically demonstrated the effects of air pollution. Other great losses to agricultural products and property are charged to air pollution.

Air is probably the most important of all our natural resources. Everyone is aware that we need fresh air every few seconds in order to live. Less well known are the enormous demands upon our air supply—measurable in thousands of cubic miles annually—to sustain our modern technological way of life. Far more air than fuel, even in terms of actual weight, is used in all combustion processes, from burning gasoline in the family car to burning coal in a huge electric powerplant.

These processes replace usable air with potentially harmful pollutants, and the capability of the atmosphere to disperse and dilute these pollutants—especially in urban areas where people, vehicles, and industries tend to congregate in even greater numbers—is strictly limited.

Polluted air, like polluted water, is costly to our economy as well as a hazard to our health. To assure safe drinking water, our communities install treatment works and purification processes for the water which enters the distribution systems. Similar purification and distribution systems for air are impractical. Consequently, to provide safe air for its citizens, the community must curtail the discharge of pollutants into the air.

Polluted air is carried from one political jurisdiction to another. Providing air of good quality to all of our people is a challenge and an obligation for Government operations on all levels. The Committee on Public Works of the U.S. Senate is prepared to accept this challenge and to do its part in meeting this obligation.

In order to better understand the nature of the problem and the needs, I instructed the staff of the committee to assemble a comprehensive report on air pollution—the problem, the needs, and Federal and State activity.

The staff, with the assistance of the Public Health Service, reviewed existing information and submitted a questionnaire to the States, the replies to which were used as a basis for the chapter dealing with State activity.

The Division of Air Pollution of the Public Health Service provided invaluable technical assistance in completing the report. I wish to particularly acknowledge the assistance given by Charles D. Yaffe, Thomas F. Williams, and Samuel M. Rogers, of that Division.

EDMUND S. MUSKIE,
Chairman, Special Subcommittee on Air and Water Pollution.

SUMMARY

This report demonstrates that across the Nation, the problem of air pollution grows ever more serious. Current efforts by industry and Government to lift the curtains of smog which more and more frequently veil our cities, from coast to coast and border to border, are meeting with only limited success. The rapid deterioration of the quality of our air has reached the point at which more effective control measures can no longer be postponed. To underline this point, research continues to provide new evidence that air pollution is objectionable, not only for its esthetic and nuisance efforts, which we can see and smell, and its economic damages, which are more varied and costly than we had supposed, but also because of its hazards to health and safety.

Pollution is increasing faster than our population increases, because our rising standard of living results in greater consumption of energy and goods per person, and our production and transportation activities increase on both accounts.

Technical procedures are available which can prevent the discharge of most contaminants to the air. The application of some of these procedures involves considerable cost. However, failure to use them is now costing the public far more in economic damages, even aside from the nuisances and hazards to health associated with air pollution.

Despite the lack of satisfactory answers to certain specific problems, such as motor vehicle pollution and sulfur oxides from fossil fuels, a significant reduction of pollution from most of our problem sources is now possible through more widespread application of proven control principles.

In this country, we have only begun to attack air pollution realistically. The Federal program of research and technical assistance has defined important facets of the problem and provided guidance to States and communities in assessing the nature of their local problem and demonstrating remedial measures.

One-third of the States have established programs to deal with air pollution, but most of these are, so far, quite limited in scope. Local government programs, where they exist, are generally understaffed and without sufficient financial and trained manpower resources to meet their needs properly. Only 34 local programs have annual budgets exceeding $25,000 and 7 of these are in California. Of the other 51 local air pollution control agencies, 21 try to function on less than $10,000 per year. In the past decade, despite a 30-percent increase in urban population, there has been, outside of California, no overall increase in manpower to combat air pollution at the local level.

It has been estimated that in 1961 major air pollution problems existed in 308 urban places. This represents an increase of 84 in a decade. About 7,300 places, housing 60 percent of the population, are confronted with air pollution problems of one kind or another.

The American public looks forward to a growing population, an expanding economy, and an improving state of well-being. Essential to this is clean air. To compensate for past neglect of air quality conservation, a greater effort is required now, by the public, by industry, and by governmental agencies at all levels. The nationwide character of the air pollution problem requires an adequate Federal program to lend assistance, support, and stimulus to State and community programs.

There is a need for the establishment of air quality standards in terms of known and suspected effects on what is necessary for the protection of human health and welfare, agriculture, and property.

A number of States do not have air pollution control laws; others have laws which have control authority only, or no control authority, but local option legislation and research and technical assistance authority.

It is quite evident that an aggressive program of research needs to be directed toward providing assistance in developing appropriate State and local air pollution control laws and standards. There is also a need for nationwide enforcement and standards and in addition consideration needs to be given to the international aspect of air pollution.

A STUDY OF POLLUTION—AIR

CHAPTER I—THE PROBLEM

Air Requirements

Air is essential for survival. This statement applies not only to the air we need for breathing but also to the air needed to sustain the kind of world in which man presently lives. Heating our homes, running our factories, driving our cars, burning our wastes—all depend upon air. The amounts required are enormous. The supply of air is fixed as are our supplies of other natural resources such as coal, petroleum, iron ore, uranium, water, and other substances we gather from our environment. We realize that these are not limitless and must be conserved, and we must take the same view of our air resources.

Approximately a ton of air is required for every tankful of gasoline used by a motor vehicle. A ton of air occupies a volume of about 25,000 cubic feet. The billion gallons of fuel consumed annually by motor vehicles in the United States use 94 trillion cubic feet—or 640 cubic miles of air.

Other fuels need comparable quantities of air. Burning a ton of coal consumes about 27,000 pounds of air, and a gallon of fuel oil about 90 pounds of air, while approximately 18 pounds of air are used in burning a pound of natural gas. About 3,000 cubic miles of air must be provided annually to satisfy the oxygen requirements of the fossil fuels presently used in the United States alone.

Other nations also share the atmsophere and make demands upon it as a source of oxygen and a receptacle for waste products. While atmospheric purification processes may remove many pollutants before they can travel from one continent to another, it is quite evident, as demonstrated by nuclear testing in the atmosphere, that pollution can circle the earth a number of times before reaching the ground. Also, as will be discussed later in this report, air pollution has the potential for worldwide influences on weather. The present world population of 3 billion is expected to reach 4.5 billion by 1980. The increasing worldwide demands upon, and pollution of, the common air resource can reduce the quality of air which reaches the United States, making adequate control that much more essential.

What Are Pollutants?

What is the nature of airborne wastes, and where do they come from?

Matter exists in three forms—solid, liquid, and gaseous. Air itself is a mixture of a number of gases, principally nitrogen (78.09 percent),

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oxygen (20.95 percent), and argon (0.93 percent). Small amounts of a number of other gases are normal constituents of air. Among these are neon, krypton, helium, hydrogen, xenon, and ozone. Carbon dioxide, although normally constituting only 0.03 percent of the atmosphere, is of special interest and importance because of its role in the life processes of animal and vegetable life and its influence on the temperature of the atmosphere. Green plants, utilizing the energy of sunlight, manufacture carbohydrates from carbon dioxide and water, and release oxygen. Animals, including man, use the oxygen and release carbon dioxide. Carbon dioxide is also produced whenever we burn carbonaceous fuels, such as wood, coal, gas, oil, or paper. With the steadily increasing rate of consumption of such fuels, there is evidence of a gradual increase in the carbon dioxide content of the air, which in turn is believed by many scientists to be causing a rise in the temeprature of the earth's atmosphere.

Air is never completely "pure." Other gases, such as sulfur dioxide, hydrogen sulfide, carbon monoxide, and methane, are discharged into the air by such natural occurrences as volcanic eruptions, forest fires, and the decay of vegetation. Wind and other disturbances distribute and suspend particulate contaminants in the form of tiny fragments of solid matter and liquid droplets. Some pollution of the air, from natural processes, is occurring all of the time.

The contaminants we discharge into the air mirror virtually all of our activities which utilize materials for domestic, commercial, agricultural, industral, or other purposes. The burning of fuels to heat our homes, and to propel our automobiles, trains, planes, and missiles; the conversion of raw materials into finished goods; the application of pesticides and fertilizers to increase our crops; the exploration into the capabilities of nuclear energy; the burning of trash and garbage; the clearing of land; the construction of roads and buildings—each of these puts foreign substances into the air.

These foreign substances are not the only aerial pollutants which result from our activities. For after these pollutants enter the atmosphere, a great deal of chemical and physical activity occurs—much more than was realized only a few years ago.

Though not yet fully explained, recent research has revealed that complex reactions take place in the air. It is know that the rate and extent of some of these changes are influenced by energy from the sun. In many instances, the presence of airborne particulate matter also has significant effects. Apparently, contaminant gases may be attracted to, and concentrate on, the surfaces of these particles, and this leads to a speedup of chemical reactions. Some of these particulates have catalytic properties; that is, the ability to promote or speed up reactions without themselves undergoing a change. Only the exposed surface of a catalyst can provide this stimulus. The surface area of a solid increases tremendously as the material is divided into smaller and smaller pieces. The relative surface area of particles small enough to remain floating in air is enormous, and a small weight of such finely divided catalyst can exert remarkable effects.

Some of these atmospheric reactions result in the conversion of harmful compounds into secondary compounds which do no injury. On the other hand, secondary compounds can be formed which are more dangerous or otherwise more objectionable than those originally

discharged into the air. For example, one of the compounds thought to be responsible for eye irritation in the type of smog first noted in Los Angeles is peroxyacetyl nitrate—referred to, for short, as PAN. This substance is produced in the air by the action of sunlight on automotive exhaust gases.

The term "smog" originally referred to a combination of smoke and fog, such as is frequently encountered in London, where coal is widely used for domestic heating as well as industrially. The word later was applied to the pollution problem of the Los Angeles area, even though neither smoke nor fog is particularly involved. It is through studies of this problem that much of the existing knowledge of atmospheric reactions was developed. Our scientists now refer to this type of pollution as "photochemical smog," since it has been shown to arise largely from a series of chemical reactions brought on or accelerated by solar energy. The principal primary contaminants involved are hydrocarbons and nitrogen oxides. The motor vehicle is one of their chief sources.

Photochemical smog, in objectionable amounts, is being found with increasing frequency in a number of cities throughout the Nation. As the basic ingredients are present everywhere and our urban population continues to grow, such smog will occur, with increasing intensity, in an ever greater number of localities.

The effects of photochemical smog are not necessarily limited to those areas where the pollutants are emitted. Since several hours may be required for the transformation of the original pollutants into the more harmful secondary products, the air mass involved may drift a considerable distance from the primary pollution sources before its maximum potential for adverse effects is reached. Thus control measures are often required, not only for the benefit of the community where the pollution arises but also for the protection of its neighbors.

The Magnitude of Pollution

Pollution of natural origin, as from volcanic eruptions, forest fires, and dust storms, is generally uncontrollable, but fortunately, in most localities, is rarely of major significance in terms of the total air pollution problem. The problem owes its importance to man and his activities.

As the number of people on earth increases, there is more air pollution. The United States, in achieving the world's highest standard of living, however, is finding that air pollution is increasing at an even faster rate than its population growth would suggest. This is related to our increasing per capita production and consumption of goods and services, which entail a vastly greater utilization of combustible materials, as well as other activities which pollute the air. This trend has accelerated as our Nation has grown from a primarily agricultural economy to a highly industrialized one.

The steady rise in per capita income has enabled the average citizen to own more goods, to replace them more often, to travel more, and in various other ways to avail himself of increased material benefits. To supply these wants has required greater production and energy generation at rates considerably in excess of the rate of population growth.

From the Report of the National Fuels and Energy Study Group to the Committee on Interior and Insular Affairs, U.S. Senate, Sep-

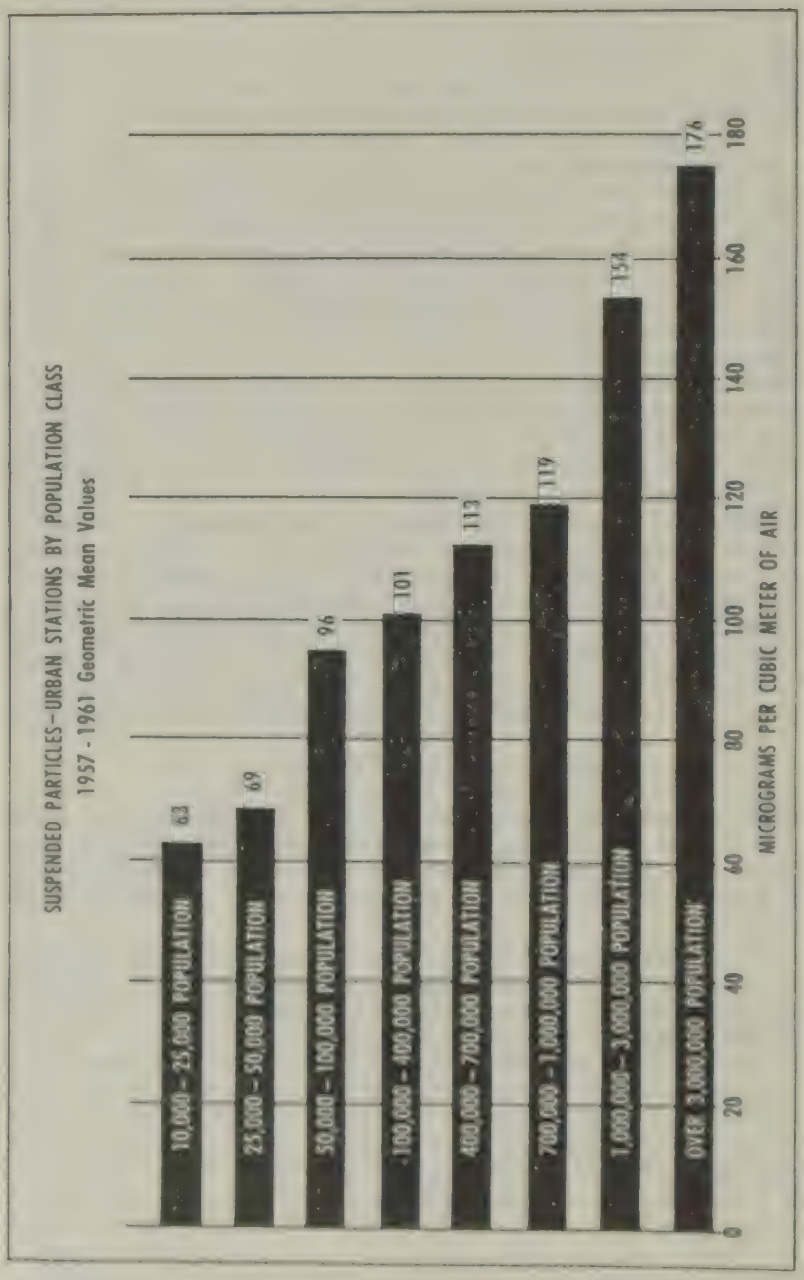
SUSPENDED PARTICLES—URBAN STATIONS BY POPULATION CLASS
1957 - 1961 Geometric Mean Values
10,000 – 25,000 POPULATION
63
25,000 – 50,000 POPULATION
69
50,000 – 100,000 POPULATION
96
100,000 – 400,000 POPULATION
101
400,000 – 700,000 POPULATION
113
700,000 – 1,000,000 POPULATION
119
1,000,000 – 3,000,000 POPULATION
134
OVER 3,000,000 POPULATION
176
0
20
40
60
80
100
120
140
160
180
MICROGRAMS PER CUBIC METER OF AIR

FIGURE 1

tember 21, 1962, are the following projections of annual energy and fuels requirements:

	Present	1980
Power consumption (trillions of British thermal units)	41,000	82,000
Generation of electric energy (billions of kilowatt-hours)	770	2,700
Oil consumption (billions of barrels)	3.4	5.7
Coal consumption (millions of tons)	400	800
Gas consumption (trillions of cubic feet)	10	20

NOTE.—These figures, which show a twofold overall increase of annual energy and fuel requirements, indicate that the demands on our fixed air supply will also increase greatly by 1980.

The quantities of pollutants discharged into the air are so great as to be difficult to visualize. For example, it has been estimated [1] that for every 1,000 gallons of gasoline used by cars, there are discharged 3,000 pounds of carbon monoxide, 200 to 400 pounds of hydrocarbons, and 50 to 150 pounds of nitrogen oxides, as well as significant amounts of such other contaminants as aldehydes, sulfur compounds, organic acids, ammonia, lead, and other metallic oxides. Applying these figures to the Nation as a whole gives the following figures for the daily discharge from motor vehicles:

	Tons
Carbon monoxide	250,000
Hydrocarbons	16,500–33,000
Nitrogen oxides	4,000–12,000

Translating the carbon monoxide figures into volume shows that vehicles discharge enough of this gas each day to pollute the air to a concentration of 30 parts per million, up to a height of nearly 400 feet over an area of 20,000 square miles, equal to the combined areas of Massachusetts, Connecticut, and New Jersey. Thirty parts per million is the concentration which for an 8-hour exposure is classified as "adverse" according to the State of California standards of ambient air.

Another example of the magnitude of pollution is obtained by estimating the sulfur dioxide produced by coal, which, while one of the most important, is certainly not the only source of sulfur dioxide pollution. Assuming coal with an average sulfur content of 2 percent, the daily discharge would be 48,000 tons of sulfur dioxide. In terms of volume, this would be enough to pollute the air up to a height of 400 feet over an area of more than 46,000 square miles, an area larger than the State of Pennsylvania, to a concentration of 1 part per million, a concentration sufficient to damage vegetation.

Particulates, or minute separate particles of matter, discharged into our air may arise from many sources: incomplete combustion of fuels, wastes from metallurgical, chemical, and refining processes, and incineration—to name a few. Consequently, comparable, meaningful estimates of *total discharges* of solid particulate contaminants may not be practicable. However, we do have much useful information on the *concentrations* of particulates which are suspended in the air. Since 1956 the National Air Sampling Network of the Public Health Service has obtained data throughout the country on such contaminants, from communities of all sizes as well as from rural areas. One important finding from this network is the consistent relationship of particulate pollution to population, as shown in figure 1.

[1] Los Angeles County Air Pollution Control District.

The Effects of Urbanization

The continuing movement of an ever larger percentage of the population into urban areas has concentrated the discharge of waste products from combustion into a very small proportion of the atmosphere, hereby intensifying the problem of air pollution. This results in the exposure of more and more people to more and more pollution without any corresponding increase in the available air supply.

Two thirds of the population of the United States reside in the 212 standard metropolitan statistical areas, which have a combined area of 310,233 square miles, representing approximately 9 percent of the total land area of the United States. The concentration of population is perhaps even more emphatically shown by the fact that, in 1960, 95,848,487 persons resided in 213 urbanized localities which have a combined area of only 25,544 square miles. In other words, 53 percent of the people live on considerably less than 1 percent of the land area. Over half of the people are so concentrated that they average more than 3,750 per square mile.

Further, in a number of areas, many urbanized localities are located closely enough together so that pollution from one can adversely affect another. Such problems are frequently of an interstate nature, as shown by figure 2.

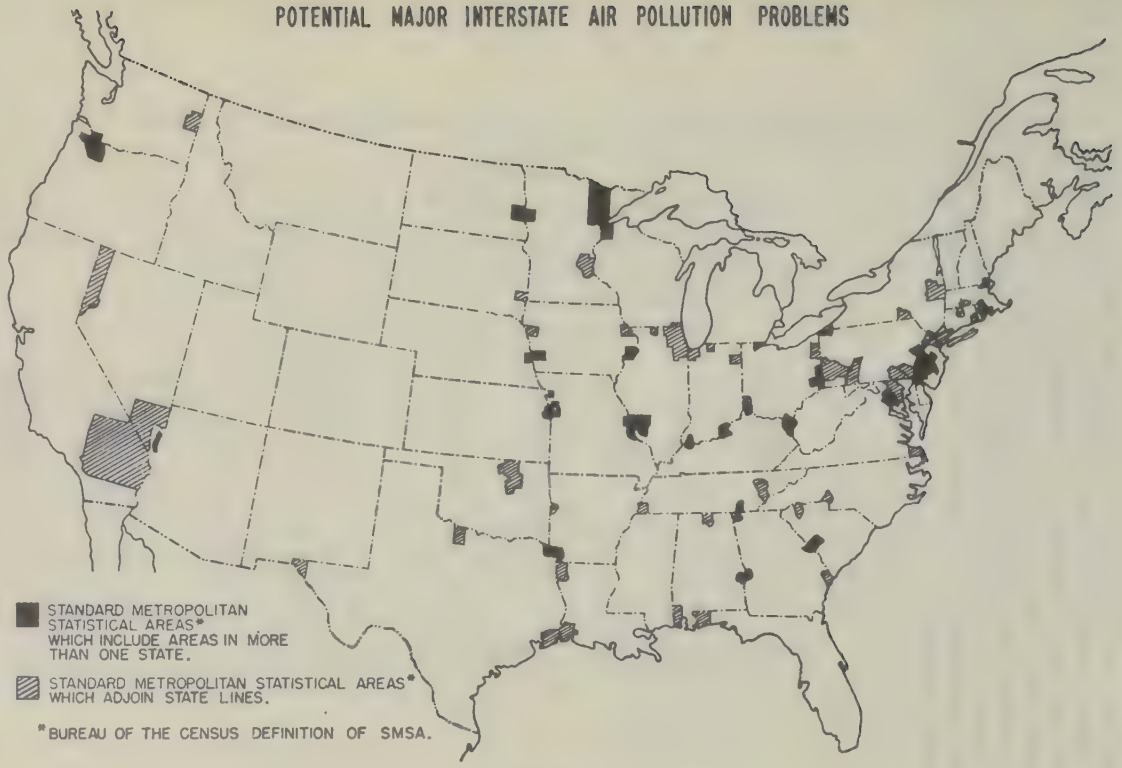
POTENTIAL MAJOR INTERSTATE AIR POLLUTION PROBLEMS
STANDARD METROPOLITAN STATISTICAL AREAS* WHICH INCLUDE AREAS IN MORE THAN ONE STATE.
STANDARD METROPOLITAN STATISTICAL AREAS* WHICH ADJOIN STATE LINES.
*BUREAU OF THE CENSUS DEFINITION OF SMSA.

FIGURE 2

In small communities, air pollution problems often affect only certain neighborhoods and are caused by a single source, or a few major sources, of pollution. As the size of a community increases, the proportion of the total area affected tends to increase, due to an increase in the number of pollution sources. While individual opinions will will vary on the severity of a given situation, the estimates presented in table I reflect to a degree the views, in 1961, of a number of State and local control officials. These indicate "major" air pollution problems in 308 urban places. This is an increase of 84 over the number 10 years earlier. About one quarter of the Nation's population resides in these 308 communities. About 7,300 places, housing 60 percent of the population, are confronted with an air pollution problem of one kind or another.

TABLE 1.—*Estimated*[1] *number of places with air pollution problems and population exposed to air pollution*[2]

[1960 population in thousands]

Population class	All urban places		Major problem			Moderate problem			Minor problem			All problems		
	Number in class	Approximate population	Places		Approximate population	Places		Approximate population	Places		Approximate population	Places		Approximate population
			Percent	Number		Percent	Number		Percent	Number		Percent	Number	
Urban places:														
1,000,000 or more	5	17,500	100	5	17,500	0	0	0	0	0	0	100	5	17,500
500,000 to 1,000,000	16	11,100	70	11	7,800	30	5	3,300	0	0	0	100	16	11,100
250,000 to 500,000	30	10,700	45	13	4,800	45	14	4,800	10	3	1,100	100	30	10,700
100,000 to 250,000	81	11,600	25	20	2,900	50	40	5,800	25	21	2,900	100	81	11,600
50,000 to 100,000	201	13,800	20	40	2,800	35	70	4,800	45	91	6,200	100	201	13,800
25,000 to 50,000	432	14,900	10	43	1,500	25	108	3,700	45	194	6,700	80	345	11,900
10,000 to 25,000	1,134	17,600	8	91	1,400	20	227	3,500	37	420	6,500	65	738	11,400
5,000 to 10,000	1,394	9,800	3	42	290	12	168	1,200	35	487	3,400	50	697	4,890
2,500 to 5,000	2,152	7,600	2	43	150	10	215	760	28	602	2,100	40	860	3,010
Unincorporated parts of urbanized areas		9,900			3,800			2,300			2,300			8,400
Subtotal	5,445	124,500	5	308	42,940	15	847	30,160	33	1,818	31,200	53	2,973	104,300
Urban and rural places under 2,500	14,345	11,100										[3] 30	4,300	3,300
Grand total	19,790	135,600	5	308	42,940	15	847	30,160	33	1,818	31,200	37	7,273	107,600
Percent of total U.S. population [4]		76			24			17			17			60

[1] Accuracy of estimates not to be inferred from number of significant digits reported.
[2] Urban places as defined by U.S. Department of Commerce, Bureau of the Census.
[3] Problems are mostly minor.
[4] Total U.S. population in 1960 was 179,323,000.

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The Influence of Weather on Pollution

Weather has an important influence on air pollution. Pollutants may be dispersed by one or another degree in two principal ways: Horizontally by wind and vertically by rising air currents.

Daily variations in wind speed depend on large-scale high- and low-pressure systems. As a rule, however, the wind blows hardest in the early afternoon, with the minimum speed generally occurring during the early morning hours.

The weather patterns are also influenced by hills, mountains, lakes, and oceans. During warm weather, the air over land heats more during the day than does air over water. The lowest air layer on land warms quickly, making the air unstable, so that it rises. This induces an inland flow of cooler air from the sea, and sets up the well-known sea breezes. These breezes generally extend upward less than 2,000 feet, and gradually decrease both in speed and height as they move inland, diminishing by about half in 10 to 15 miles. Above these breezes there is a return circulation from land to water. At night, particularly on clear nights, the land cools faster than the water and so cools the low air layer on the land quickly. The heavier land air spills seaward, where the lower air stays warm longer and sets up a land breeze, thus reversing the airflow pattern. These breezes, prevailing from about 2 hours after sunset until 2 hours after sunrise, are not as strong, and extend up only a few hundred feet.

Similar patterns develop in mountainous locations, due to different rates of heating and cooling along the slopes of valleys. On clear days the earth's surface heats rapidly, and promptly warms the adjacent layer of air. Strong convection currents then flow up sloping surfaces. They induce colder upper air to subside into the valley, giving strong air circulation over the terrain. On clear nights the earth's surface cools faster than the upper air and cools the lower air first. Cooled air flows downward and accumulates in valleys, causing stagnant inversions by trapping warm air above.

While such local flows can sometimes prevent periods of sustained exposure, they can also result in polluted air flowing back across the source area, thereby permitting higher concentrations to build up through additional discharges into the already polluted air.

Wind speed also changes with the seasons. As an example, in both the Appalachian Mountains in the east and over the Great Basin area in the West, there will be, in fall and early winter, long periods of atmospheric stagnation, with only light winds, or none.

The rate at which pollution can rise depends upon changes in the air temperature with height. Ordinarily, air becomes cooler with increase in height. If the temperature drops more than 5.4° F., per 1,000 feet, warm polluted air, being lighter, will continue to rise. But if the temperature decrease with height is less than 5.4° F., a stable condition occurs and pollutants tend to remain in the air layer into which they are discharged.

If a layer of warm air is above air which is cooler, the normal temperature gradient is reversed. The layer of warm air then acts as a "lid," and pollution does not rise above it. This is a thermal inversion.

Such inversions are common in all areas of the United States, occur-

ring between 10 percent and 50 percent of the time at elevations of 500 feet or less, as shown by the following table:

Annual percent of hours of inversion based at or below 500 feet

Region:	Percent
Atlantic coast	10–35
Appalachian Mountains	30–45
Great Lakes	20–30
Gulf coast	10–35
Central Plains	25–40
Rocky Mountains	35–50
Northwest Pacific coast	25–30
West coast	35–40

The intensity and duration of inversion depends upon how rapidly the earth cools at night and warms in the morning. These rates are affected by clouds, topography, and the season. Fall months generally have more total hours of inversion conditions, but a single inversion condition is likely to last longer during the winter.

The importance of inversions to the air pollution problem is shown by the following example.

Inversion conditions developing over a city during the night frequently persist until 3 or 4 hours after sunrise. This means that the pollution from the morning traffic peak is held down until late morning or early afternoon. Again, conditions which restrict the dilution of pollution often arise at the time of the peak of evening traffic. Ironically, the two daily periods of maximum automobile traffic frequently coincide with the two daily periods least satisfactory for the escape of pollution.

Figure 3 illustrates how various combinations of temperature and wind conditions can affect the dispersal of pollution.

Figure 3.—Effects of wind and temperature on spread of pollution.

CHAPTER II—EFFECTS OF POLLUTION

The insidious effects of air pollution are many—all of them undesirable. Pollution harms our health, reduces our crop yields, damages our property, affronts our senses, and lessens our enjoyment of life.

What Does Air Pollution Do to Health?

The cost of illness, of decreased strength, and of shortened lifespan cannot be measured in dollars. There can be no price tag for the health effects of air pollution. If there could be, its amount would far exceed all other costs combined.

In London, England, in December 1962, at least 340 people died because of a smog which persisted for only a few days.

Other catastrophes of this type, brought on by periods of inversion and weather stagnation, have occurred in the past. Some of them probably were not even recognized. London itself had similar weather conditions in December 1952, which brought on a "pea soup" fog lasting 5 days. A review of the records, some months later, showed that there were 4,000 more deaths than usual during the week beginning with the first day of the fog. Following this disaster, the British passed a Clean Air Act designed to reduce pollution. Improved coal burning practices required by that act have reduced the amount of particulate matter in the air. This is credited, in part, with the lower death toll from the 1962 smog, in which sulfur dioxide levels were similar to those in 1952. Other measures undoubtedly also helped. For one, there was available an emergency plan for prompt hospitalization and treatment of acutely affected persons. Also, as a result of an educational program, many people minimized their exposures by remaining indoors as much as possible and by otherwise protecting themselves. Consequently, only 340 deaths were officially ascribed to the 1962 episode.

While the air pollution problems of the United States differ from those in Great Britain, similar calamities have occurred in this country. Until recently, the one usually mentioned was that which struck Donora, Pa. in October 1948, where one-third of the population of 14,000 became ill and 17 died. This episode was recognized immediately as a disaster. In contrast, an episode that occurred in New York City in November 1953 was not recognized until statistical evidence presented almost 9 years later disclosed that during a brief period of weather stagnation at that time, in which unusually high levels of sulfur dioxide and smoke shade had been recorded, the number of deaths in New York had been approximately 200 in excess of normal.

This disaster attracted far less attention than the loss of a comparable number of lives in the collision of airliners over the same city. With respect to this accident, it might be added that the conditions

of poor visibility which may have been in part responsible for the collision were undoubtedly aggravated by air pollution.

Of much greater overall significance than acute episodes is a growing body of evidence that long-term, low-level air pollution can contribute to and aggravate certain diseases. As the "Report of the Panel on Health Considerations" at the 1962 National Conference on Air Pollution states:

> It would be a mistake to leave this conference with the impression that there is insufficient evidence for action now. The evidence that air pollution contributes to the pathogenesis of chronic respiratory disease is overwhelming. The classical concept of one agent being responsible for one disease is • • • an investigational convenience • • • the demonstration of a cause and effect, or one-to-one relationship is an unrealistic approach to this problem • • • the interactions of various chemical irritants, of infections agents, and of carcinogenic substances together with meteorological factors as affecting human respiratory health, are entirely what should be expected of complex man in his complex environment. Neither these complicated interactions nor the variabilities of the types of pollution in different communities should be used to camouflage the need for action.

Prolonged exposure to low levels of airborne toxic substances may have many health effects. Primary interest centers, logically, on the respiratory system through which these poisons most easily enter the body.

There is strong evidence that air pollution is associated with a number of respiratory ailments. These include: (1) nonspecific infectious upper respiratory disease, (2) chronic bronchitis, (3) chronic constrictive ventilatory disease, (4) pulmonary emphysema, (5) bronchial asthma, and (6) lung cancer.

(1) The "common cold" and other *upper respiratory tract infections* have been shown to occur more frequently in areas which have higher pollution levels. This has been demonstrated by investigators in Great Britain, Japan, and the U.S.S.R., as well as in the United States. Epidemiologic studies make it clear that acute nonspecific upper respiratory disease accompanies moderate levels of air pollution common in our communities.

The laboratory provides further evidence that pollution makes us more susceptible to such infections. Experiments have shown that animals inhaling the organisms which produce pneumonia are more likely to develop the disease if they are first exposed to low concentrations of ozone or nitrogen oxides.

Ciliary activity, the wavelike motion of the microscopic hairlike formations which line the air passages, is an important protective mechanism for removing infectious agents and injurious chemicals from those passages. It is decreased or stopped as a result of breathing irritant air pollutants. This too has been proved by laboratory experiments.

(2) Nearly 10 percent of all deaths in Great Britain result from *chronic bronchitis*. Many studies there have shown positive connections between air pollution and the occurrence, severity, and aggravation of this disease.

Partly because of differences in definitions and terminology, chronic bronchitis has generally not been a well recognized clinical entity in the United States. However, the condition, or a very similar one, is beginning to be found more often than had been suspected. One investigation, using the British criteria, found chronic bronchitis in 21 percent of men 40 to 59 years of age.

(3) The effort required for breathing is increased as a result of breathing irritant air pollution. Studies have shown that pollution, at levels sometimes occurring in urban environments, can cause a constriction in breathing passages. This can lead to a long-continued nonspecific respiratory condition referred to as *chronic constrictive ventilatory disease.* While healthy individuals may not notice the extra breathing effort imposed by airway constriction, this added burden may be serious, even unbearable, for persons whose hearts or lungs are already functioning marginally.

(4) *Pulmonary emphysema* is a disease in which the very fine air sacs of the lung become abnormally stretched, resulting in a loss of functioning vital lung tissue. The growing importance of this disease is shown by figure 4, which indicates the rapid increase during recent

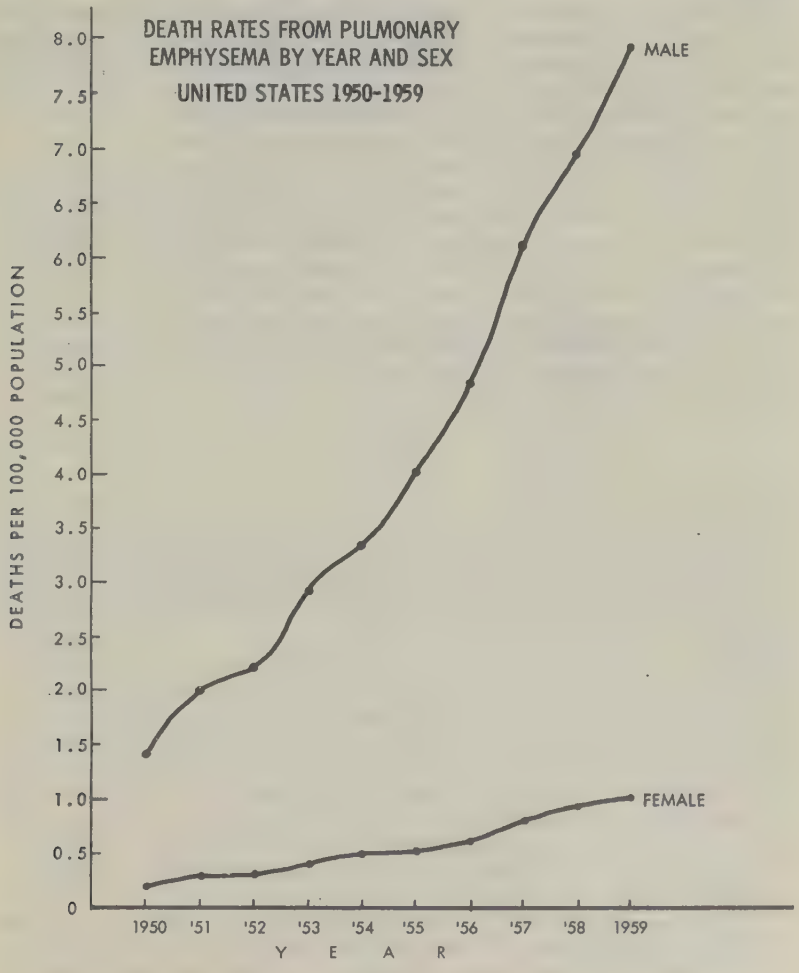

FIGURE 4

years in deaths attributed to emphysema. The extent and cost of this disease are further emphasized by social security figures. Among 179,419 persons receiving monthly payment in 1960 for disability from serious illness, pulmonary emphysema was the proven primary medical diagnosis in 6.9 percent (or 12,380) of the cases. Only arteriosclerotic heart disease, including coronary disease, exceeded this number, accounting for 19.9 percent. It is estimated that the payments to individuals for whom emphysema is the primary medical diagnosis is about $60 million per year.

Pulmonary emphysema seems to be increasing especially in urban areas. Air pollution is suspected of being responsible for much of this. In addition there is the demonstrated fact that individual patients with emphysema become worse when exposed to irritant air pollution.

(5) *Bronchial asthma* is another condition which, in many instances, is definitely made worse by air pollution. There is, of course, a long list of stimuli capable of triggering asthmatic attacks and it is not surprising that irritant air pollutants are included in the list. It is interesting to note that one of these, sulfur dioxide, has been reported to be an allergenic agent with respect to asthma.

As early as 1946, a condition considered to be an epidemic of asthmatic bronchitis appeared among American troops stationed in the highly industrialized Yokohama area of Japan. The condition soon appeared also among dependent family members living in the area. In time, the condition was also recognized as occurring in our military personnel in the Tokyo area. The cases did not respond to usual medication for asthma, but the symptoms generally disappeared when the individuals were evacuated from the area. If allowed to remain in the area a few months to a year, many individuals develop permanent lung disability, probably in the form of pulmonary emphysema.

The condition is still under detailed study. Among the findings thus far are the following: it is estimated that 3 to 5 percent of the exposed American personnel develop the disease; it occurs in epidemic form in late fall and early winter, when the usual allergens of plant origin are not present in the air; it is unclear whether the native population have the disease, although it is known that they do have true allergic bronchial asthma; few of the patients report a history of allergy in themselves or their families; removal from the area, especially if early, results in recovery in most cases; and there is a good correlation between frequency of attack and air pollution levels.

In New Orleans, La., epidemic outbreaks of asthmatic attacks among patients known to have the disease have been associated with particular local wind conditions. Specifically, the attacks have been found to be most common when there are light winds flowing in from abandoned, smouldering city dumps. Skin tests with a characteristic airborne particle, derived from burning fibrous material, have given positive results among individuals who develop the acute attacks.

Other instances of bronchial asthma brought on by irritant air pollutants have occurred in the United States.

(6) *Lung cancer*, with its many unanswered questions, presents a problem much too complex to be reviewed in detail in a concise report of this kind. It is appropriate, however, to consider briefly some of

the indications that air pollution is one of the environmental factors contributing to the increasing frequency of the disease.

The lung cancer rate is higher in cities. This cannot be fully explained by other recognizable factors, such as cigarette smoking or nature of occupation. The air carries many substances which are potential cancer producers. The concentrations of these materials are higher in city air. Figure 5 shows how the airborne concentration

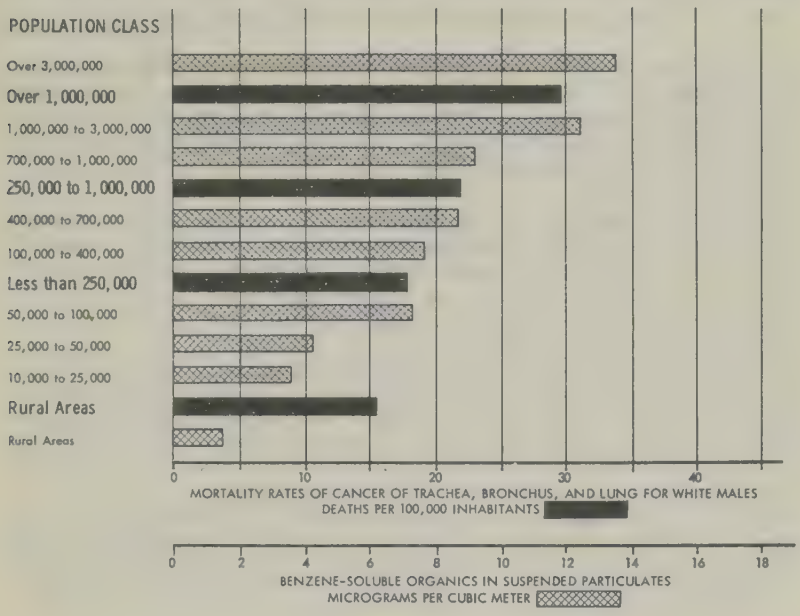

FIGURE 5

of an important group of these agents increases with the size of community. It also shows how death rates from respiratory system cancers have a similar relationship. This group of chemicals, separated from particulate matter collected from the air, has produced cancer when applied to the skin of susceptible laboratory animals or injected into them.

A change in air environment apparently can affect one's chances of getting lung cancer. Persons emigrating to New Zealand or South Africa, after long residence in heavily polluted Great Britain, have greater rates of lung cancer than those of persons of similar ethnic backgrounds and smoking habits who are native to those countries, but lower rates than those who remain in Great Britain. Conversely, persons coming to the United States from Norway have lower cancer rates than native Americans of similar backgrounds but higher rates than among those who remained in the cleaner air of their own country. These relationships have been demonstrated in four independent studies.

Mice which had recovered from induced influenza developed lung cancer after inhaling ozonized gasoline, a substance quite similar to the

photochemical smog found in many areas. Similar mice which did not inhale the ozonized gasoline did not develop cancer. Likewise, mice which had not had influenza did not develop cancer, even though they were exposed to the ozonized gasoline.

These and other findings given strong indications that air pollutants, either alone or acting in conjunction with other factors, contribute to the development of respiratory cancer.

Air Pollution Is Costly to Agriculture

The nature and extent of air pollution damage to vegetation has been changing, just as air pollution has been changing. Until recent years, the destruction of foliage on a serious scale was primarily due to sulfur dioxide, of which classical examples occurred at Copper Hill, Tenn., and in the State of Washington from the smelter at Trail, British Columbia.

With the expansion and development of new industrial processes and products, a variety of contaminants is now sometimes present in harmful concentrations. Augmenting the problem are the emissions from motor vehicles and the secondary pollutants resulting from chemical reactions in the air. A significant result of these additional plant poisons has been the rapid spread of damage to many previously untouched areas of the Nation. Reports of extensive injury to farm crops, as well as to ornamental shrubbery, have been received from many States. Whether reported or not, without question, vegetation suffers from air pollution in and around every large concentration of population.

Recent research in plant pathology has demonstrated that the kinds of plants affected and the nature of injury produced vary with the agent. This has made it possible to identify some of the specific pollutants which injure plants and to prove that, in some cases, they have caused damage as far away as 100 miles or more from the point where they originate.

OZONE

The Southeastern Forest Experiment Station of the U.S. Department of Agriculture has recently reported evidence, based on studies of trees in West Virginia, that the cause of *[illegible] tipburn*, a blight of eastern white pine, is probably ozone, a contaminant associated with motor vehicle pollution.

The great economic significance of ozone damage was not recognized until 1958, when it was found, in California, that lesions in grape leaves observed in the field could be reproduced by a 3 hour fumigation with only one half part per million of ozone. Ozone has also been shown to be responsible for flecking of tobacco leaves in the eastern part of the United States.

As a result of observed damage to spinach crops in New Jersey in 1958, studies were begun in that State the following year. A recent report from the New Jersey Department of Plant Pathology stated that, so far, they have observed ozone injury not only to spinach, but also to alfalfa, rye, barley, orchard grass, tobacco, petunia, radish, red clover, bean, parsley, grape, and perhaps chicory, endive, broccoli, carnation, and pine. Results of a similar nature were obtained from fumigations conducted in Utah.

That this kind of damage is not limited to the immediate vicinity of great cities is indicated in the New Jersey report, which concludes with this statement:

> With the sources of contamination, cars, home, and industrial fires, refineries, etc., being so numerous both in and bordering New Jersey, it is not surprising that test tobacco plants placed in 14 different locations in New Jersey during the growing season just past, showed injury from ozone in every location. It appears therefore that this is a problem which, while being most serious near such cities as Philadelphia and New York, can be expected to affect sensitive plants in all areas of the State.

By 1961, damage from oxidants had already been observed in 19 States (Arizona, California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Indiana, Maryland, Massachusetts, Missouri, North Carolina, New Jersey, New York, Ohio, Pennsylvania, Utah, Washington, and West Virginia), the District of Columbia, and the Province of Ontario, Canada, as well as in Baja California, Mexico. In 1955 it was reported that such damage had been seen in Bogotá, Colombia; Cologne, Germany; Copenhagen, Denmark; London and Manchester, England; Paris, France; and São Paulo, Brazil.

FLUORIDES

Fluorides are another class of contaminants that have caused extensive vegetation damage. Being primarily of industrial origin, fluoride damage is generally associated with specific, fixed sources. In many such situations livestock, foraging on vegetation on which airborne fluorides have been deposited, have suffered serious adverse effects.

Although hydrogen fluoride and sulfur dioxide are both acid gases, their effects on vegetation vary. Corn and peach, for example, are quite susceptible to hydrogen fluoride, but both are resistant to sulfur dioxide. The reverse is the case for certain other species of plants.

Hydrogen fluoride is a gas which is extremely poisonous to vegetation. Some gladiolus plants have been injured by concentrations as low as 1 part per 10 billion parts of air.

OTHERS

Examples of some vegetation-damaging pollutants have been given. Others of importance, such as ethylene and peroxyacetylnitrate, have also been identified. Much additional research is needed to ascertain the full cost to agriculture of air pollution. In addition to visible damage, retardation of plant growth and reduction in yield require careful study. Effects on livestock also should be investigated more thoroughly.

The economic losses are presently difficult to measure. As interest in air pollution effects on vegetation grows, the vast cost is beginning to be appreciated. This is exemplified by the report from the Panel on Agricultural, Natural Resource, and Economic Considerations at the 1962 National Conference on Air Pollution, which states:

> The agricultural losses resulting from the adverse effects of all of the presently recognized pollutants have been estimated to amount to hundreds of millions of dollars a year.

Property Losses Are Enormous

Accurate data are not available on the extent and cost of air pollution damage to property. Various cost estimates have been made. One frequently employed is $65 per capita per year. This would represent an annual cost to the Nation of over $11 billion. Whatever yardsticks are employed, it is clearly evident that the cost of property damage alone from air pollution is great -- far greater than the amounts devoted to its abatement by industry and all levels of government.

Air pollution causes the accelerated deterioration of materials, structures, and machines of all kinds. This in turn greatly increases maintenance and replacement expenditures. In addition, air pollution is responsible for a general depreciation in property values which affects neighborhoods and even entire communities.

Most common materials are adversely affected by pollution. Metals corrode, fabrics weaken and fade, leather weakens and becomes brittle, rubber cracks and loses its elasticity, paint discolors, concrete and building stone discolor and erode, glass is etched, and paper becomes brittle.

Sulfur dioxide, a common contaminant in the air of virtually all towns and cities, causes deterioration of many materials. It attacks metals, particularly iron and steel. Limestone, marble, roofing slate, mortar, and other carbonate-containing stone, are partially converted to water-soluble sulfates, which are leached away by rain. Sulfur dioxide has an affinity for leather, causing it to weaken and rot. Costly damage to upholstery and book bindings has been produced by its action. Cotton, wool, and nylon are all weakened by sulfur dioxide.

Another sulfur compound, hydrogen sulfide, reacts with lead compounds to form black lead sulfide. Houses covered with lead-based paints often suffer severe discoloration from even single exposures to this gas.

Hydrogen sulfide also tarnishes copper and silver. The coating formed on open electrical contacts of these metals can increase electrical resistance and may result in welding the contacts together in the closed position.

Important among the many property-damaging effects of photochemical smog is the excessive cracking of rubber. This is due to oxidants in the atmosphere, particularly ozone. So rapid is the action that measurement of crack depth in rubber is used as a method for determining ozone concentrations in the air. Ozone also causes deterioration in a number of dyes and fabrics, of both natural and synthetic materials. Fading is also produced by nitrogen oxides.

The primary effect of airborne solid particulate matter is soiling. While this does not directly result in deterioration of materials, such as fabrics or structures, the removal of the deposited grime is often costly and may shorten the life of such materials; for example, clothes wear out more from laundering than from wearing.

The presence of particulates apparently greatly accelerates the destructive action of those gases which corrode metals, just as particulates mixed with inhaled gases apparently increase the harmful effects of the gases on the respiratory system.

The cost, because of air pollution, of replacing or protecting precision instruments and other equipment affected by pollutants is un-

doubtedly high. The complex and expensive control systems which are becoming so commonplace in modern technology can be ruined, or seriously damaged, by the corrosive action of gaseous pollutants or by deposited dust. To prevent such damage, many industries—for example, those engaged in the manufacture of high-precision components for telecommunication or space vehicles—must clean, at considerable expense, air admitted to the plants in which such items are produced.

In the average home, air pollution is responsible for additional expenses—for example, more frequent painting of exterior and interior walls and more frequent cleaning of clothing and home furnishings, such as rugs and draperies—which can easily add up to substantial amounts per year. In neighborhoods where residents are unable or unwilling to incur such expenses, the resultant depreciation of property values may cost even more, to both individuals and the community.

Air Pollution Is a Safety Hazard

Air pollution represents a definite hazard to land, water, and air transportation, because it reduces visibility. Any source of dense smoke close to a modern high-speed highway can pose a serious threat to travelers. In at least two recent instances—one in Pennsylvania close to a smoldering culm pile, another in Louisiana near a burning dump—the sudden application of brakes by a single motorist led to a chain reaction which involved the wrecking of a number of vehicles and injuries to many of their occupants. The same thing has occurred on the New Jersey Turnpike. Similar accidents as well as unexpected delays on this account are probably frequent throughout the Nation.

Air pollution is not only hazardous, but also costly, where aircraft operations are involved. Normal fog, of course, sometimes slows up air travel. The addition of pollutants to the fog often reduces visibility enough to ground aircraft which are not fully equipped with appropriate blind-flying instruments. Even when planes have the best available instruments, the aggravation of poor weather conditions by pollution results in delays in landings and departures at busy airports. This is costly to people traveling on business and very expensive to the carriers. As long ago as 1946, a survey showed that the number of hours during which visibility was cut to 6 miles or less at Newark Airport as a result of smoke alone, or smoke in combination with other obstructions, totaled 4,359 hours, or almost 50 percent of the total hours during the year.

A review by the Civil Aeronautics Board of 1,660 record cards, representing one-third of the aircraft accidents in the United States in 1962, showed 6 in which "obstructions to vision" (by smoke, haze, sand, and dust) were listed as a cause. Two of the six aircraft were classified as large, one of them being a commercial carrier. If the sample studied is representative, a total of 15 to 20 plane crashes in 1962 may be attributed to this cause.

Pollution contributes to fog formation and undoubtedly aggravates visibility problems in which natural conditions play a major role. Where accidents are attributed to impaired visibility due to weather, it is likely that, in many instances, the risk had been increased by air pollution.

Air Pollution Affects Our Weather

Air pollution causes many local changes in the atmosphere. It decreases the amount of sunshine reaching the earth, cutting down particularly on ultraviolet radiation. It reduces the natural illumination, which requires us to provide more artificial light, particularly in winter. It increases the frequency and density of fog, with the resultant loss of visibility and its attendant hazards. It increases cloudiness. Under some circumstances, it increases local precipitation in urban areas.

As stated earlier, there is evidence that the amount of carbon dioxide in the atmosphere is increasing as a consequence of human activities. This increase is raising the temperature of the earth's atmosphere by intercepting infrared heat waves going out from the earth into space. An increase in heat will lead to more violent air circulation and thus to more destructive storms.

Air pollution's effects on the weather, therefore, can be significant on a large scale as well as locally.

Recreational, Esthetic, and Psychological Effects

The recreational, esthetic, and psychological effects of air pollution overlap not only each other but also the economic effects. The contraction of the horizon by curtains of smog that can slow up or cancel air flights can also spoil the tourist's view of a natural wonder. The growing of green things that is one man's income is another man's recreation and a source of esthetic satisfactions. When ozone blights a pine forest, it may not only destroy industrial resources, but also ruin the forest for vacationers or sportsmen.

This is also true of simpler and commoner occurences. A man may touch a soot-coated window ledge or car fender and then the cuff of his freshly laundered shirt. The economic effect of the resulting black smudge may be no more than a few pennies in laundry bills, but the effects on his disposition and peace of mind may be substantial. The golfer—or anyone who is out of doors for pleasure—enjoys seeing the open sky, unclouded by manmade haze.

There is also a certain overlap between this kind of effect and health considerations. No permanent health effects have been demonstrated as a result of smog induced stinging and tearing of the eyes, but this is highly uncomfortable and irritating in more than the literal sense. Diesel exhaust is possibly a lesser health hazard than the exhaust from gasoline motors, but the motorist who is held up behind an idling bus is not thinking of long range health effects: he simply resents the sight and the smell of those diesel fumes.

Wholly apart from health or economic considerations, the recreational, esthetic, and psychological effects sometimes seem, to some groups and individuals, serious enough on their own account to call for remedial action. It will never be possible to measure these effects accurately in quantitative terms, if only because they affect different people differently. To the flower lover whose ornamentals refuse to grow, to the art lover who sees his city's memorial buildings and statues defaced by grime or slowly crumbling because of sulfur compounds, to the sportsman who notes the recent slaughter of ducks and fish by airborne crop sprays—these effects of air pollution may seem the most obnoxious of all.

CHAPTER III—HISTORY OF FEDERAL PROGRAM

Public Law 84–159

An indentifiable Federal program in air pollution was not established until 1955, when Public Law 159 was passed by the 84th Congress. This was entitled "An act to provide research and technical assistance relating to air pollution control."

Prior to the passage of this act, only limited work had been done in the field of air pollution. The Bureau of Mines, for example, did some studies on the nature and control of pollution from fuel combustion, and the Public Health Service, under Public Law 78–410, conducted certain studies and investigations—in particular the one involving the Donora, Pa., episode of 1948.

Public Law 84–159 supplemented the authority provided by the Public Health Service Act (Public Law 78–410) to the Secretary of Health, Education, and Welfare: (1) To prepare or recommend research programs for devising methods of controlling air pollution; (2) to encourage cooperative activities by State and local governments; (3) to collect and disseminate information relating to air pollution; (4) to conduct research to devise and develop methods of prevention and abatement and to support such work conducted by other governmental and private agencies; (5) to conduct research, surveys, and investigations concerning any specific problem of air pollution, upon request of any State or local governmental air pollution control agency, and (6) to make grants to, and enter into contracts with, other governmental and private agencies and individuals for surveys, studies, research, training, and demonstration projects.

In 1960, Public Law 86–493 directed the Surgeon General to study the problem of motor vehicle exhausts and their effects upon human health, and to submit a report to the Congress within 2 years. This report, entitled "Motor Vehicles, Air Pollution, and Health," was published in 1962 as House Document 489.

Public Law 84–159 authorized a maximum appropriation of $5 million for each of 5 fiscal years. Subsequently, the time period of the authorization was extended by amendment of the act. Public Law 86–365 extended the authority for an additional 4 years to June 30, 1964 and Public Law 87–761 further extended the period to June 30, 1966.

No substantive change in the authority of the Public Health Service with regard to air pollution has been made since passage of Public Law 84–159 in 1955. An amendment, contained in Public Law 87–761, included a directive to continue work on motor vehicle exhausts as called for in Public Law 86–493. Public Law 86–365 added another amendment declaring the intent of Congress that Federal agencies shall cooperate with the Department of Health, Education, and Wel-

fare and with State and local air pollution agencies in preventing or controlling air pollution from sources under the control of such Federal agencies.

Monetary appropriations for air pollution since inception of the Federal program are summarized as follows:

[In thousands]

	1955	1956	1957	1958	1959	1960	1961	1962	1963
Research:									
Intramural		566	855	1 263	1 276	2 081	2 988	3 821	4 402
Contract		316	800	1 117	1 177	1 326	1 563	1 760	2 378
Grants		402	500	500	700	444	400	1 044	2 806
Total	180	1 784	2 155	2 880	3 153	3 851	4 951	6 625	9 586
Technical assistance		150	430	500	455	597	450	580	681
Training:									
Direct		40	70	147	146	151	253	268	309
Grants			100	146	146	146	118	113	454
Total		40	184	293	292	297	340	371	763
Grand total	180	1 722	2 740	3 293	3 800	[1] 5 581	[1] 6 667	8 800	11 466

[1] Including transfer for research grants operations from NIH.

With the enactment of Public Law 84-159 in 1955, the Public Health Service began its work in air pollution through two mechanisms. One was the establishment of an engineering air pollution program which began limited technical assistance activities and research into the sources, nature, concentration, and control of air pollutants. Laboratory facilities for parts of this work were developed at the Robert A. Taft Sanitary Engineering Center in Cincinnati. The remainder of the work was undertaken through contracts and grants. The other mechanism was the creation, at the same time, of a medical air pollution program, for the primary purpose of evaluating health effects of air pollution. Since facilities were lacking at the beginning for conducting research, it was inaugurated almost entirely through grants and contracts. By 1960, sufficient progress had been made, and enough problem areas defined, to justify combining the two programs into the present Division of Air Pollution, which was established on September 1, 1960, and under which there is a coordinated approach to the overall problem.

While continuing to make use of the research resources of educational institutions and other private or public agencies through contracts or grants, the Division has also strengthened its own research capabilities. The passage of Public Law 86-493 in 1960, provided a particular stimulus to research, accelerating the development of facilities and personnel for the study of motor vehicle pollution problems.

Program Objectives

The Public Health Service air pollution program to date has been based on the philosophy that the primary responsibility for the regulatory control of air pollution rests with the States and local governments, and that the Federal role should be a supporting one of research, technical assistance to public and private organizations, and training of technical personnel.

The basic objectives of the program are threefold: (1) To improve the status of knowledge about the causes and effects of air pollution and about the means of controlling it within acceptable limits; (2) to apply present and future knowledge to the actual control of air pollutants through technical assistance to States, communities, and industry; and (3) to stimulate all levels of government, industry, and the general public to devote increased attention and greater resources to the prevention and control of air pollution. A National Advisory Committee on Air Pollution helps to guide the policies and program. The Committee has representation from industry, control agencies, and other interested segments of the public.

Research

Air pollution research conducted or sponsored by the Public Health Service has explored many facets of the problem.

In the field of engineering, the research has dealt with such matters as the amounts, character, and control of automotive exhaust and crankcase emissions; incineration of refuse and other combustion problems; and control procedures, including studies of contaminant behavior, collection mechanisms, and performance characteristics of control equipment. Field surveys of industrial sources have also been undertaken to determine the amounts and nature of materials actually being discharged by certain processes.

Chemical research has developed new and appropriate analytical methods of the necessary sensitivity, and with these has explored the chemistry and movements of the atmosphere, and examined and developed basic data on "clean" atmospheres.

Air monitoring has been accomplished through the establishment of a national air-sampling network of approximately 250 stations (fig. 6) which provide data on suspended particulate matter in both urban and nonurban locations in every State on a year-round basis. A gas-sampling program is now also included at 50 of these stations. Since 1962 more complete data are being obtained by continuous automatic sampling and recording equipment located in eight cities.

Extensive investigation into the meteorological aspects of air pollution has accompanied other research activities of the Public Health Service. This has been accomplished through the closest possible cooperation of the Weather Bureau, with a number of its personnel being stationed in the Public Health Service laboratories. Research has been conducted on the relationships of meteorological variables to air quality, the diffusion of pollutants, and the effects of topography, vegetation, and structures on temperature and wind. Meteorological research has made it feasible to establish a nationwide program by which air pollution potential is forecast, with telegraphic warnings being sent to appropriate State and local officials when indicated.

Biomedical research has likewise been extensive and productive. Population surveys have provided meaningful data on many relationships of air pollutants to sickness or death.

In laboratories and hospitals, the mechanisms of response to pollutants have been studied and biochemical, physiological, and pathological measurements of reactions have meen made. Studies have

FIGURE 6

been made with a variety of toxic materials, with cancer-producing agents, and with allergens.

In addition to the effects on animal life, related research on vegetation has likewise been carried on, in close cooperation with the Department of Agriculture.

Technical Assistance

An extension of knowledge of air pollution has also been gained through such technical assistance activities of the Public Health Service as field surveys, demonstration grants, and short-term assistance to State and local agencies on special projects.

The primary objective of the technical assistance program, however, is to help in the establishment or strengthening of State and local air pollution control agencies. Such aid is rendered in a variety of ways, dependent upon the specific situation. Since the inauguration of the Federal program, major technical assistance projects of the Public Health Service have included 8 major field investigations, 16 statewide surveys and some assistance in 4 other State surveys, 12 local surveys to provide a basis for program initiation, and 56 short-term technical studies of limited scope. In a number of instances, personnel have been loaned to States or communities for periods of up to 2 years. The locations and nature of such services are tabulated as follows:

MAJOR FIELD INVESTIGATIONS (APRIL 1955 TO MAY 1963)

1. Louisville-Jefferson County, Ky.
2. Nashville-Davidson County, Tenn.
3. Lewiston, Idaho-Clarkston, Wash.
4. New York-New Jersey area (in cooperation with the Interstate Sanitation Commission).
5. Jacksonville-Duval County, Fla.
6. Berlin, N.H.
7. Detroit-Wayne County, Mich.-Windsor area, Ontario (International Joint Commission) (continuing at limited level).
8. Interstate St. Louis Metropolitan area (in progress).

STATEWIDE AIR POLLUTION SURVEYS (APRIL 1955 TO MAY 1963)

1. Washington
2. Connecticut
3. Tennessee
4. Texas
5. New York
6. North Carolina
7. Minnesota
8. Pennsylvania
9. Florida
10. Georgia
11. South Dakota
12. Colorado
13. Kansas
14. Oklahoma (in progress)
15. Mississippi (scheduled)
16. South Carolina (scheduled)

Assistance was also given to conduct of statewide surveys in California, Illinois, Montana, and Utah but main responsibility rested with the respective States.

LOCAL SURVEYS (APRIL 1955 TO MAY 1963)

Surveys conducted primarily to provide a basis for program initiation:

1. Portland, Oreg.
2. Steubenville, Ohio
3. Denver area, Colo.
4. Birmingham, Ala.
5. Salt Lake Valley, Utah
6. Elmira, N.Y.
7. Charleston, S.C.
8. Hamilton, Ohio
9. Lynchburg, Va.
10. Washington, D.C. area
11. Spartanburg, S.C.
12. Dade County, Fla.

LOCAL TECHNICAL STUDIES OF LIMITED SCOPE (APRIL 1955 TO MAY 1963)

1. Short-term air quality measurement demonstrations done largely by PHS but with local participation:

(*a*) Phoenix, Ariz.
(*b*) Tucson, Ariz.
(*c*) Fresno, Calif.
(*d*) Washington, D.C.
(*e*) Birmingham, Ala.
(*f*) Richmond, Va.
(*g*) Providence, R.I.
(*h*) Spartanburg, S.C.
(*i*) Lynchburg, Va.
(*j*) Winston-Salem, N.C.
(*k*) Pittsburgh, Pa. (mobile laboratory)

2. Short-term technical studies done in conjunction with statewide surveys:

(*a*) Atlanta, Ga.
(*b*) Minneapolis, Minn.
(*c*) St. Paul, Minn.
(*d*) Duluth, Minn.
(*e*) Fergus Falls, Minn.
(*f*) Asheville, N.C.
(*g*) Charlotte, N.C.
(*h*) Greensboro, N.C.
(*i*) Raleigh, N.C.
(*j*) Umstead Park, N.C.
(*k*) Kansas City, Kans.
(*l*) Topeka, Kans.
(*m*) Wichita, Kans.

3. Short-term technical studies done primarily to evaluate influence of specific sources of pollution (April 1955–April 1963).

(*a*) St. Bernard, Ohio
(*b*) Baccus, Utah
(*c*) Lexington, Ky.
(*d*) Galveston, Tex.

4. Short-term technical studies done primarily by other agencies but with substantial assistance from Division of Air Pollution:

(*a*) Denver, Colo.
(*b*) Hamilton, Ohio
(*c*) Wheeling-Weirton, W. Va.-Steubenville, Ohio area.
(*d*) El Paso, Tex.

LOAN OF PERSONNEL

Agencies to which Division of Air Pollution personnel were on loan 3 months or longer during calender year 1962:

Location	*Purpose*
California State Department of Public Health.	Conduct studies of effects of carbon monoxide and lead on humans.
Delaware State Board of Health.	To establish air quality measurement program and to provide other support.
Florida State Board of Health.	To carry on program, to replace men who quit or had gone to school for further training.
New York City.	For training and orientation and to provide program support.
San Francisco Bay Area, Air Pollution Control District.	For training and orientation and to provide program support.
New York State Air Pollution Control Board.	For training and orientation and to provide program support.
Oregon State Sanitary Authority.	For training and orientation and to provide program support.
Pennsylvania Division of Air Pollution Control.	For training and orientation and to provide program support.
Indiana State Board of Health.	To help initiate new programs.
Chicago Department of Air Pollution Control.	Revise, rebuild, and prepare long-range plans for program; assist with technical studies.
Metropolitan Washington, D.C.	Design, organize, and help operate oxidant sampling network.

TRAINING COURSES

A major technical assistance function of the program is the training of personnel from State and local agencies, and also from industry. This is accomplished through a variety of short courses, usually of one or two weeks' duration, presented at the Robert A. Taft Sanitary Engineering Center in Cincinnati. These are supplemented by field courses presented in various convenient locations. Since inception of the training program in 1955, instruction has been given to 5,837 individuals through 116 presentations of 41 different courses. The nature of these courses is illustrated by the titles of those being presented during fiscal year 1964:

Sampling and Identification of Aero-Allergens.
Elements of Air Quality Management.
Control of Gaseous Emissions.
Control of Particulate Emissions.
Diffusion of Air Pollution, Theory and Application.
Measurement of Airborne Radioactivity.
Medical and Biological Aspects of Air Pollution.
Microscopic Analysis of Atmospheric Particulates.
Analysis of Atmospheric Inorganics.
Analysis of Atmospheric Organics.
Meteorological Aspects of Air Pollution.
Atmospheric Survey.
Source Sampling for Atmospheric Pollutants.
Design of Air Pollutant Sampling Trains.
Orientation in Air Pollution.

TRAINING GRANTS

More extensive training at graduate level at a number of universities is also now being provided through training grants to these institutions and to many of their students. As of August 1, 1965, a total of $[illegible] in training grants had been allocated during fiscal year 1965 to the following institutions:

University of Cincinnati.
[illegible]
[illegible]
University of Florida.
New York University.
[illegible]
University of Michigan.
[illegible]
[illegible]
University of Illinois.
University of Southern California.
[illegible]

As of August 1, 1965, a total of $[illegible] had been allocated during fiscal year 1965 for fellowships at the following schools:

Auburn University.
California Institute of Technology.
University of California at Riverside.
Massachusetts Institute of Technology.
University of Michigan.
University of Minnesota.
Washington University, St. Louis, Mo.
Columbia University.
Clarkson College of Technology, Potsdam, N.Y.
University of Cincinnati.
[illegible]
University of Texas.

Additional fellowships for training grants and fellowships are under active consideration for the expectation that a total of $[illegible] million may be appropriated for those purposes.

INTERAGENCY COOPERATION

Approximately 10 percent of the funds authorized for the Public Health Service, exclusive of grants for research and training grants, are [illegible] with other Federal agencies for the conduct of air pollution research.

During 1965, [illegible] the Weather Bureau received $[illegible] for meteorological studies of dispersal of community air pollution; [illegible] the Bureau of Mines $[illegible] for a number of projects on either [illegible] caused from the gas [illegible] of fuel oil, pollutants from power [illegible] and control of pollutants from motor vehicle exhaust; [illegible] the National Bureau of Standards $[illegible] for research on [illegible] aspects of chemical reactions and analytical procedures, (4) the [illegible] $[illegible] for the preparation of [illegible] on air pollution, and (5) the Library of Congress $[illegible] for technical abstracts on air pollution.

A number of Federal agencies have programs in fundamental properties of either the upper or lower atmosphere. The research which they conduct often has some relationship to the subject of air pollution but since air pollution is only [illegible] the primary purpose of such research, it is not included in the foregoing discussion. Agencies engaged in such work include AEC, NASA, FAA, NSF, and the [illegible] Departments of Defense, Commerce, Interior, and Agriculture. The Public Health Service [illegible] appropriate funds will come [illegible] through the Interdepartmental Committee on Atmospheric Sciences of the Federal Council on Science and Technology.

CHAPTER IV—STATE, LOCAL, AND NONGOVERNMENTAL PROGRAMS

In 1947 California adopted a statute authorizing the formation of county air pollution control districts. Oregon, in 1951, passed a law creating an air pollution study and control program. Since that time, many States have adopted air pollution legislation of some kind.

Inquiries by Senate Public Works Committee

On April 30, 1963, Senator Pat McNamara, chairman of the Senate Public Works Committee, sent letters to the Governors of all the States and territories requesting them to answer a set of questions on the status of air pollution control legislation in their respective jurisdictions and soliciting their opinions on certain proposed Federal activities in the field. By August 15 replies had been received from all but three of the States.

The questions asked by Senator McNamara were as follows:

1. "Does your State have air pollution control laws? If so, would you give a brief digest of their principal provisions?"

2. "If your State does not have air pollution control laws, is it contemplated that such laws may be enacted?"

3. "Do you have air quality standards and emission standards? If so, what measures are taken to obtain enforcement or compliance?"

4. "Do you have air pollution problems in your State which arise from sources outside your State? If so, do you have agreements with neighboring State or States to deal with the problem, and what provisions are made to handle the matter?"

5. "Does your State have a State-financed program of air pollution control research?"

6. "Would it be helpful to your State if the Department of Health, Education, and Welfare would recommend air quality standards and emission standards and assist in obtaining compliance with such standards?"

7. "General suggestions on how to cope with air pollution."

Supplemental information regarding State air pollution laws was also obtained from the Public Health Service, including information about the three States which had not replied to the questions. A detailed summary of the replies received, together with a digest of State air pollution laws, is presented in appendix I.

Briefly, 33 of the States and territories have some type of air pollution control laws and 18 do not. Fifteen have some control authority. Twelve have no control authority, but have local option legislation. Six provide only research and technical assistance. Of the 18 having no air pollution control laws, 10 indicated some interest in promoting such legislation. Three have studies of the problem underway, and 5 have made unsuccessful efforts to pass air pollution control legislation.

The States of California and Oregon have established air quality and emission standards which are enforced on a local or statewide

basis. California also has motor vehicle emission standards. New York is in the process of establishing air quality standards and the establishment of such standards is authorized in seven States. Four States have emission standards for one or a few pollutants.

Nineteen units report having air pollution problems originating outside their jurisdiction, while twenty-nine report none so originating. Six States have formal or semiformal mechanisms dealing with interstate air pollution problems. Five States have made some attempt to cope with this problem by working along informal, cooperative lines.

Ten States have legislation authorizing air pollution control research, but only three conduct fairly extensive programs.

With respect to the Department of Health, Education, and Welfare recommending air quality standards, 37 States approve, 1 approves with qualifications, and 12 disapprove. Concerning emission standards recommendations from the Department, 33 approve, 1 approves with qualifications, and 14 disapprove.

With respect to the suggestion of Federal participation in the enforcement of air pollution control standards, 19 approve but 9 of these had qualifications, and 23 disapprove.

Budgetary Support for State and Local Programs

In 1961, the most recent year for which reasonably complete figures are available, only 17 States were spending as much as $5,000 per year on air pollution programs (table 2). Of the total expenditure of $2 million, 57 percent was spent by the State of California.

In 1961, there were 85 local agencies budgeting at least $5,000 per year each for air pollution control (table 3). Of their total expendi-

Table 2.—*State air pollution programs, 1961 (those spending $5,000 per year or more)*

State	Land area (1,000 square miles)	Population, 1960 (millions)	Type of program [1]	Budget, fiscal year 1961	Personnel 1961
California	157	15.7	Technical assistance and research	$965,000	45
			Motor vehicle pollution control	855,000	17
Colorado	104	1.8	Technical assistance	15,000	[2] 4
Connecticut	5	2.5	do	7,500	1
Delaware	2	4	Compliance survey	[3] 18,000	1
Florida			Technical assistance (Orange Lake)	12,000	1
Special districts	54	5.0	Compliance survey in Polk-Hillsborough Counties	80,000	7
Hawaii	6	6	Compliance survey	16,000	2
Maryland	10	3.1	Cooperative studies	37,750	3
Massachusetts			Compliance	28,000	145
Metropolitan Boston	8	5.1	Regulatory program operated by the State	82,000	8
Michigan	58	7.8	Technical assistance and studies	20,000	[2] 10
Minnesota	80	3.4	Technical assistance	5,000	[2] 2
New Jersey	8	6.1	Compliance survey	150,000	14
New York	48	16.8	do	225,000	20
Ohio	41	9.7	Technical assistance and studies	46,000	7
Oregon	96	1.8	Compliance survey	65,000	8
Pennsylvania	45	11.3	do	60,000	9
Texas	264	9.6	Technical assistance and studies	[2] 2,800	1
			do	24,000	[2] 4
Washington	66	2.9			3
Total		101.6		2,686,250	148
					[2] 29

[1] Compliance survey (inspection for compliance with control), technical assistance, studies, etc.
[2] Part time.
[3] 1959 estimate.

TABLE 3.—*Local air pollution control programs (with annual budget of $5,000 or more, Feb. 1, 1961)*

	Population 1960 (thousands)	Staff [1]	Budget (thousands)	Per capita budget (cents)	Staff per 100,000 population
Agencies with budgets of $25,000 or more per year:					
1. San Francisco Bay area, California	3,364	31.0	$560	16.7	0.9
2. Los Angeles County, Calif.	5,970	373.0	3,402	57.0	6.3
3. Orange County, Calif.	698	11.0	117	16.8	1.6
4. Sacramento County, Calif.[2]	500	4.0	50	10.0	.8
5. San Bernardino County, Calif.	498	8.0	[2] 259	52.0	1.6
6. Riverside County, Calif.	302	4.0	67	22.2	1.3
7. San Diego County, Calif.	1,000	4.5	79	7.9	.5
8. District of Columbia [3]	746	6.0	42	5.6	.8
9. Polk-Hillsborough Counties, Fla.[4]	592	4.0	50	8.5	.7
10. Chicago, Ill.	3,512	42.0	364	10.4	1.5
11. Indianapolis, Ind.	469	6.0	38	8.1	1.3
12. Jefferson County (Louisville), Ky.	606	11.0	63	10.4	1.8
13. Baltimore, Md.[3]	922	10.0	70	7.6	1.1
14. Boston metropolitan district, Massachusetts[4]	1,998	8.0	52	2.6	.4
15. Detroit, Mich.	1,654	20.0	180	10.9	1.2
16. St. Louis, Mo.	747	13.0	118	15.8	1.7
17. Newark, N.J.[3]	403	10.0	63	15.6	2.5
18. Buffalo, N.Y.[3]	530	6.0	59	11.1	1.1
19. New York, N.Y.	7,710	74.0	734	9.5	1.0
20. Niagara Falls, N.Y.	102	3.0	28	27.4	2.9
21. Syracuse, N.Y.	215	5.0	36	16.7	2.3
22. Cincinnati, Ohio (area)[3]	542	18.0	165	30.4	3.3
23. Cleveland, Ohio	870	23.0	236	27.1	2.6
24. Cleveland Heights, Ohio	62	4.0	28	45.3	6.5
25. Columbus, Ohio	469	7.0	50	10.7	1.5
26. Dayton, Ohio [3]	258	7.0	55	21.3	2.7
27. Allegheny County, Pa.	1,629	18.0	217	13.3	1.1
28. Philadelphia, Pa.	1,971	23.0	166	8.4	1.2
29. Providence, R.I.[3]	206	8.0	31	15.0	3.9
30. Knoxville, Tenn.[3]	110	2.0	25	22.7	1.8
31. Harris County, Tex.[3]	1,243	6.0	42	3.4	.5
32. Salt Lake City, Utah	189	4.0	30	15.8	2.0
33. Richmond, Va.	218	4.0	25	11.4	1.8
34. Milwaukee County, Wis.	733	15.0	128	17.5	2.1
Total or median for group	40,929	802.5	7,629	14.1	1.6
Agencies with budgets of less than $25,000 per year:					
1. Birmingham, Ala.	341	2.0	12	3.5	.6
2. Denver, Colo.	494	2.0	15	3.1	.4
3. Dade County, Fla.	935	[5] 1.0	5	.5	----------
4. Atlanta, Ga.	485	1	13	2.7	.2
5. Cicero, Ill.	69	[5] 1.0	5	7.2	----------
6. Peoria, Ill.	103	1.0	8	7.8	1.0
7. East Chicago, Ind.	58	1.0	11	19.3	1.7
8. Evansville, Inc.	140	1.0	10	7.2	.7
9. Des Moines, Ia.[3]	208	[5] 2.0	11	5.3	----------
10. McCracken County (Paducah), Ky.	57	1.0	12	20.9	1.8
11. Dearborn, Mich.	112	[5] 2.0	5	4.5	----------
12. Grand Rapids, Mich.	175	[5] 2.0	6	3.4	----------
13. Monroe, Mich.	23	1.0	6	26.1	4.3
14. Wayne County, Mich.	2,666	1.5	20	.8	.06
15. Minneapolis, Minn.	478	1.0	11	2.3	.2
16. Omaha, Nebr.	300	2.0	20	6.7	.7
17. Camden, N.J.	125	1.0	7	5.6	.8
18. Hillside Township, N.J.	21	[5] 3.0	5	23.8	----------
19. Perth Amboy, N.J.	38	1.0	13	34.2	2.6
20. Trenton, N.J.	114	1.0	5	4.4	.9
21. Ilion, N.Y.	10	1.0	5	49.0	1.0
22. Rochester, N.Y.	316	1.0	10	3.2	.03
23. Tonawanda, N.Y.	84	2.0	15	17.9	2.4
24. Watertown, N.Y.	33	1.0	7	21.2	3.0
25. Asheville, N.C.	59	3.0	16	27.2	5.1
26. Charlotte, N.C.	201	2.0	19	9.5	1.0
27. Winston-Salem, N.C.	111	2.0	12	10.8	1.8
28. Akron, Ohio	288	2.0	16	5.6	.7
29. East Cleveland, Ohio	38	1.0	7	18.4	2.6
30. Sandusky, Ohio	32	1.0	7	21.9	3.1
31. Toledo, Ohio	316	2.0	12	3.8	.6
32. Youngstown, Ohio	166	2.0	17	10.3	1.2
33. Zanesville, Ohio	39	1.0	5	12.8	2.6
34. Eugene, Oreg.	50	1.0	10	20.0	2.0
35. Portland, Oreg.	371	1.0	17	4.6	.3
36. Erie, Pa.	138	2.0	15	10.8	1.5
37. Lehigh Valley, Pa. (area)	278	1.0	14	5.0	.4
38. East Providence, R.I.	42	1.0	8	19.1	2.4
39. Pawtucket, R.I.	81	1.0	5	6.3	1.2

TABLE 3.—*Local air pollution control programs (with annual budget of $5,000 or more, Feb. 1, 1961)*—Continued

	Population 1960 (thousands)	Staff [1]	Budget (thousands)	Per capita budget (cents)	Staff per 100,000 population
Agencies with budgets of less than $25,000—Con.					
40. Charleston, S. C.	96	1.0	6	6.3	1.0
41. Chattanooga, Tenn.[2]	128	2.0	16	12.5	1.6
42. Kingsport, Tenn.	26	1.0	7	26.6	3.9
43. Memphis, Tenn.[3]	492	2.0	13	2.6	.4
44. Nashville, Tenn.	167	2.0	13	7.9	1.2
45. Roanoke, Va.	97	1.0	11	11.4	1.0
46. Seattle, Wash.	557	1.0	45	8.2	.2
47. Tacoma, Wash.	147	1.0	8	5.4	.7
48. Wheeling, W. Va.	56	1.0	15	26.7	3.6
49. Fond du Lac, Wis.[3]	35	1.0	7	20.4	3.0
50. Green Bay, Wis.[3]	63	1.0	7	11.2	1.6
51. Madison, Wis.	126	2.0	14	11.2	1.6
Total or median for group	10,477	78.5	948	7.8	1.0
Total or median for all agencies	81,404	876.0	8,157	10.8	1.6

[1] Not including clerical personnel.
[2] 1960 fiscal year.
[3] Staff believed to spend considerable time on work other than air pollution.
[4] Operated by the State in which located.
[5] Part time.

ture of $8 million, 55 percent was spent in California in seven local units, with the Los Angeles County Air Pollution Control District accounting for over 41 percent of the money spent by local agencies throughout the United States. On a per capita basis Los Angeles spent 57 cents. The median expenditure for the 85 local programs was 10.8 cents per capita. The Division of Air Pollution of the Public Health Service reports that a satisfactory air pollution control program for a community with average present day problems requires an annual expenditure of at least 40 cents per capita.

STATE EFFORTS

The scope and nature of State programs vary considerably. Depending on the exact meaning given the word "enforcement," four to six States "enforce" air pollution regulations. More common activities are technical assistance and development of local programs. Six or more States do air quality monitoring on a statewide basis, and about the same number review and approve plans for certain installations which may cause air pollution. In New York, plans for some installations, prior to construction, must be approved by the State air pollution control board or by qualified local agencies. California has established a program for the purpose of limiting emissions from motor vehicles, and New York has followed suit to the extent of legislating for the purpose of preventing emissions from crankcases.

Among other activities of State programs are training, dissemination of information, nuisance abatement, laboratory services for local agencies, studies of pollutant emissions, and research of various types. Due to limited budgets, only a few States can engage in many of these various activities to a meaningful extent. In the 17 States having programs in 1961, the average annual expenditure for air pollution control was only 2 cents per capita, and the median was 1.2 cents. The total full-time personnel employed for such work was 148, with 29 others being engaged on a part-time basis.

Local Programs

Nine States have adopted laws which authorize cities or counties to operate air pollution control agencies with authority transcending municipal boundaries or to otherwise undertake interlocal cooperation. Thus the 85 local air pollution control agencies serve more than 85 communities. For example, the San Francisco Bay Area Air Pollution Control District serves 89 urban places of various sizes. However, of 218 urban places with more than 50,000 population which have a major or moderate air pollution problem, only 119, or 55 percent, are served by a control agency. Table 4 shows the numbers of communities of various population classes receiving services from agencies appropriating $5,000 or more per year for air pollution control. As indicated in footnote (1), no consideration of program adequacy is given.

TABLE 4.—*Urban places served by a local air pollution control agency*

[Places with 2,500 or more people; agencies spending $5,000 per year or more]

Population class	Number of places in class (1960)	Number of places with major or moderate air pollution problem (from table 1)	Places served by local air pollution control agency [1]		
			Number [2]	Percent of total	Percent of places with major or moderate problem [3]
1,000,000 or more	5	5	5	100	100
500,000 to 1,000,000	16	16	13	81	81
250,000 to 500,000	30	27	20	67	74
100,000 to 250,000	81	60	32	40	53
50,000 to 100,000	201	110	49	24	45
25,000 to 50,000	432	151	80	19	52
10,000 to 25,000	1,134	318	[4] 125	11	39
5,000 to 10,000	1,394	210	[4] 93	7	44
2,500 to 5,000	2,152	258	[4] 80	4	31
Total	5,445	1,155	497	9	43

[1] Does not include urban places served by State agencies except Polk-Hillsborough County, Fla., and the Boston metropolitan area. No consideration given to whether the agency is adequate to cope with the problem. Many are not.

[2] Larger than number of agencies because some areas serve many urban places, e.g., Los Angeles County Air Pollution Control District.

[3] Urban places with control agency and with major or moderate problem not necessarily the same. Percentages given in this column are too high by an unknown amount.

[4] All but 3 of these urban places of less than 25,000 population are served by county or district programs.

In local agencies, in contradistinction to most State programs, there is greater emphasis on control and abatement activities. An important aspect of this is prevention of new sources of excessive pollution. This is attempted by registration or permit systems for new installations. Under such systems the air pollution agency must be given notice of new installations of equipment which may discharge pollution. This eliminates the necessity of searching them out. In some instances plans for the installation may be required before the permit is issued. However, only about three fourths of the agencies serving communities of 200,000 or more population provide for plan review, and many of these only review plans for combustion equipment and do not review plans for other process equipment which may cause air pollution. In smaller communities only about one-third of the control agencies do plan reviews. Thus many new sources of pollution are constantly developing even in localities where control programs exist. It can be added, also, that abatement or elimination of existing sources is generally more difficult than the prevention of new ones.

Enforcement is not the only approach used by local control agencies. Many, some to a large degree, attempt to obtain corrections by education and persuasion.

Some local agencies do monitoring of the air to determine concentrations of pollutants, but the majority lack the funds, equipment, or qualified personnel to obtain such basic essential information. Part of this problem arises from the low salary schedules common in such agencies. A recent survey revealed the median annual salary for engineers in city air pollution control agencies to be $2,200 less than the median for all engineers, as reported by the National Science Foundation.

Since many local programs were originally directed only at smoke control the personnel employed were often selected for their knowledge of fuel firing practices. The more diverse and complex sources which now present the major problems are often outside their area of competence. In such situations there may be a natural inclination for them to concentrate efforts on only those problems which are familiar.

It has been estimated that the number of personnel in local air pollution control agencies increased about one-third between 1952 and 1961. California agencies in 1961 employed about 3.6 times as many people as in 1952. In 1961, there were 37 more local agencies than there were in 1952, but outside of the new agencies in California, only 5 employ more than 2 people. Also, during this period five local agencies were discontinued. It is evident that, except in California, little or no headway was made to bring the resources of local air pollution control agencies more into line during the past decade, while the urban population was increasing by 30 percent.

Nongovernmental Activities

In addition to the programs of official agencies, work of one kind or another in the field of air pollution is carried on or sponsored by other organizations, such as technical societies, industry associations, universities, and research institutes.

The widespread interest in air pollution is demonstrated by the many organizations which have committees working on various aspects of the problem. The Air Pollution Control Association, American Society of Mechanical Engineers, American Society for Testing Materials, American Industrial Hygiene Association, American Public Health Association, American Medical Association, National Tuberculosis Association, American Society of Civil Engineers, and American Association for the Advancement of Science are examples of technical and professional groups which are concerned about air pollution. Some of these finance research in air pollution as well as contributing through committee work.

Research is also sponsored by industry associations, such as American Petroleum Institute, National Coal Association, American Iron & Steel Institute, National Association for Stream Improvement (a pulp and paper industry organization), Manufacturing Chemists' Association, Edison Electric Institute, and Automobile Manufacturers Association.

Several of these groups are presently conducting or sponsoring cooperative projects with the Division of Air Pollution of the Public Health Service. Among these are the Edison Electric Institute, Automobile Manufacturers Association, Manufacturing Chemists' Association, and American Public Works Association.

In addition to research sponsored by industry or government, universities utilize some of their own funds for air pollution research. Some research institutes may also do some self-financed work in this field.

Organizations sponsoring research reported the following amounts being devoted to the support of 347 research projects in 1962:

Organizations supporting air pollution research	Number of projects	Funding (dollars)	Percent of total
Universities	17	548,000	4
Federal agencies	227	8,866,000	62
State agencies	18	1,027,000	7
Local agencies	11	640,000	5
Industrial organizations	38	1,890,000	13
Private (nonindustrial)	11	386,000	3
Not classified	25	799,000	6
Totals	347	14,156,000	100

A total of 466 projects was reported in the foregoing survey, indicating that the total amount actually being devoted to air pollution research in 1962 may have been as much as $20 million.

CHAPTER V—STATUS OF PRESENT TECHNOLOGY

The Measurement of Air Quality

During the past decade we have learned a great deal about the kinds and amounts of pollution in the air. More information is steadily being obtained as improved sampling and analytical equipment are developed and put into use. The National Air Sampling Network operated by the Public Health Service, as shown in figure 6 has accumulated extensive data concerning the amounts and chemical composition of particulates in the air in approximately 250 localities. Nonurban as well as urban sampling stations in all 50 States and Puerto Rico are included in this program. State and local agencies participate, operating the filter samplers and sending the samples to Cincinnati for analysis by the Public Health Service. Weight, radioactivity, and soiling measurements are made, as well as comprehensive chemical analyses.

Several common gaseous pollutants are measured at some 50 of the network stations. Included are nitrogen dioxide, sulfur dioxide and oxidants. More elaborate and extensive gas sampling is being done with automatic, continuous recording equipment at stations located in Chicago, Cincinnati, Detroit, Los Angeles, New Orleans, New York, Philadelphia, San Francisco, and Washington. In addition to the three contaminants just mentioned, these stations measure nitric oxide, carbon monoxide, ozone and total hydrocarbons. While there are many other sources of these gases, all of them, except sulfur dioxide, provide important information about pollution from motor vehicles. The sulfur dioxide is a particularly good indicator of pollution from stationary sources of fuel combustion, as well as from certain industrial processes.

A similar mobile sampling station has recently been put into operation by the Public Health Service. In addition to collecting data in various communities, it enables local officials to learn about the operation of such equipment. Because of the expense of the necessary equipment and lack of trained personnel very few localities have obtained comprehensive data on their air quality. While the number is comparatively small, regular air quality monitoring is done by air pollution control agencies of several States and communities. California has probably the most extensive programs of this type. These have been developed over a number of years by the various district programs as well as by the State.

The usefulness of such monitoring is illustrated by an oxidant sampling network operated by the Metropolitan Washington Council of Governments since the fall of 1961. Despite the absence of heavy industry sources, this network has confirmed that photochemical smog is occurring in objectionable amounts on frequent occasions. Until a satisfactory solution to the motor vehicle pollution problem is achieved,

the frequency and severity of these smogs will increase just as they did in Los Angeles. The same conclusion can be applied, of course, to virtually every large urban area.

Monitoring programs serve a variety of purposes. A newly established sulfur dioxide measuring network in Chicago will provide local authorities with valuable information about specific sources, as well as about seasonal variations and the influence of other factors.

Some industrial establishments conduct air monitoring programs in the vicinities of their own operations, but data thus obtained are not always available for general use.

Expanding Our Knowledge of Weather Effects

Advances in meteorology have broadened understanding of the forces promoting or restricting the dispersal of contaminants, and have made it feasible to predict periods when these will accumulate in above normal amounts. Of vital significance, also, is the information which is being developed on the limitations of the atmosphere's ability to dilute pollution. The total mixing or absorptive capacity of the atmosphere over broad geographic regions is of great importance in determining the adequacy of pollution control. Such capacity has distinct limitations which may persist for long periods of time. For example, in January the maximum atmospheric mixing depth throughout the United States is generally between 650 and 2,000 feet.

The maximum mixing depth (or height), as illustrated by figure 7, can be explained as follows: The lines AB and BC indicate the temperature changes with height, as measured during early morning. The direction in which AB slants shows that the temperature increases with height up to about 1,000 feet. This means that an inversion is present. Above that, the temperature decreases with increasing height, as indicated by the slant of BC. The point D shows the maximum temperature occurring later that day. The line DE is drawn to show a decrease in temperature of 5.4° F. per 1,000 feet of height. If, as it does in this case, that line intersects the measured temperature profile, the point of intersection indicates the maximum height to which pollution can rise until the inversion disappears. In the example shown, the maximum mixing height is at E, approximately 850 feet above the ground.

Under these circumstances, it is the quantity of pollutant discharge which directly determines the ground level pollutant concentration downwind after mixing in this layer.

For example, the use of tall stacks has been an accepted and widely used control procedure. The objective is to provide a means for adequate dilution and dispersion of the effluent pollution before it can return to ground level. The trend toward larger combustion and processing installations brings with it the production of larger volumes of waste products to be discharged. With the increasing population and its more extensive use of land, the distances from large pollution

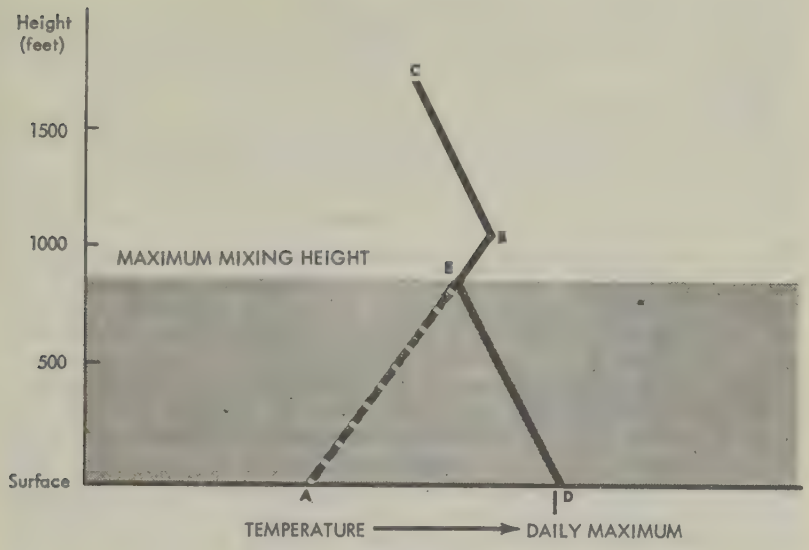

FIGURE 7

sources to urban concentrations of people become shorter or disappear entirely. To cope with this, stacks of ever-increasing height have been built. Some already exceed 600 feet, and there are proposals now under consideration for stacks 800 feet high for the dispersal of sulfur dioxide from large powerplants.

The cost of building stacks increases markedly with increasing size and height. Precise relationships cannot be presented because of many variables. However, a special report of the recent Federal Power Commission National Power Survey estimates that stack costs for projected very large conventional steam-electric generating stations might approach $3 per kilowatt as compared with an average cost of $0.70 per kilowatt for present conventional installations involving stacks of 450 to nearly 700 feet for plants of 1,200,000 to 1,500,000 kilowatt capacity. Based on these figures, while the stack for a 1,500,000-kilowatt plant might cost approximately $1 million the stack for a plant of twice this capacity could cost 5 to 10 times as much.

Unfortunately, even with such large expenditures, the high stack may not be successful in serving its purpose.

While plumes from such installations, under favorable atmospheric conditions, will rise high into the air and not return to the

ground for long distances, there are prolonged periods of time during which the available volume of diluting air is simply insufficient to satisfy the need. Tall stacks can contribute little in dealing with this situation.

The point emphasized by this is that there is often a limit to the total mass of pollution that the atmosphere can dilute satisfactorily even with the use of stacks much higher than any yet built.

Unsolved Problems

A major unsolved technical problem is how to find an economical way to prevent the discharge of sulfur dioxide from fossil fuels. There are two approaches. One is to remove the sulfur dioxide from the stack gasses. The other is to remove the sulfur from the fuel before use. Thus far, only partial success has been obtained by either avenue. It is for this reason that high stacks have been so extensively used. Even considering only the economic aspects, however, the grossly greater costs of higher stacks further emphasizes the importance of finding other ways to keep sulfur dioxide out of the air. The cost of preventing sulfur dioxide pollution may become an important factor in determining the extent to which nuclear powerplants will be able to compete with conventional plants during the coming decades.

Another major air pollution problem still lacking a satisfactory solution is emissions from motor vehicles. Despite accelerated research activities on the problem, stimulated by California legislation aimed at reducing vehicular pollution, fundamental technical questions need resolution before a satisfactory solution on a national basis is likely to be achieved.

What Can Be Done?

Despite these and other problems needing further research, our technology has reached the stage where widespread application of proven control principles could bring about a profound reduction of pollution from most of our problem sources, with a great improvement in the overall situation in many communities and areas.

Granting that further research will improve efficiencies and reduce costs, effective and reasonably economical control measures are available and in successful use for many types of pollution now being discharged. Particulate pollutant removal is accomplished by devices employing such principles as filtration, electrostatic precipitation, and centrifugal force. Liquid scrubbing, vapor recovery, combustion, and solid adsorption are examples of principles used for reducing gaseous pollution. Both gaseous and particulate pollution can sometimes be reduced through improved plant design, operating procedures, and proper maintenance of equipment.

Cost

At the 1962 National Conference on Air Pollution, figures were presented, table *b*, showing examples of the cost of various types of air pollution controls which have been installed in Los Angeles County during the past few years. In some cases, the cost of control equipment was but a small fraction of the cost of the production equipment. In other instances, the cost of the control equipment was greater than the cost of the basic equipment.

TABLE 5.—*Typical costs of basic and control equipment installed in Los Angeles County*

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment
Airblown asphalt system	500 barrels per batch	$10,500	Afterburner	$3,000
Asphalt concrete batching plant.	200,000 pounds per hour	150,000	Scrubber	10,000
Asphalt saturator	6 by 65 by 8 feet	40,000	Scrubber and electric precipitator.	50,000
Asphalt tile production	5,000 pounds per hour	150,000	Baghouse	5,000
Borax drying and classifying	10,000 pounds per hour	1,000,000	Baghouse and scrubber.	10,000
Bulk gasoline loading rack	667,000 gallons per day	88,000	Vapor control system.	50,000
Carbon black plant	2,000 gallons per day	5,000	Baghouse	5,000
Catalytic reforming unit	2,400 barrels per day	265,000	Flare and sour water oxidizer.	6,000
Ceramic tile production	8,000 pounds per hour	200,000	Scrubber	10,000
Chip dryer, aluminum	2,500 pounds per hour	3,000	Afterburner	3,000
Chrome plating	4 by 5 by 5 feet	2,000	Scrubber	800
Coffee roaster	3 tons per hour	35,000	Cyclone and afterburner.	8,000
Concrete batching plant	900,000 pounds per hour	125,000	Baghouse	10,000
Core oven	8 by 8 by 12 feet	4,000	Afterburner	1,500
Crucible furnace, yellow brass	4 furnaces at 850 pounds each, heat.	[1] 2,500	Baghouse	17,000
Crude oil distillation unit	37,000 barrels per hour	3,060,000	Vapor control system.	10,000
Cupola, gray iron	48 inches inside diameter	40,000	Baghouse and quench tank.	67,000
	27 inches inside diameter	25,000	do	32,000
Debonder	500 brake shoes per hour	1,800	Afterburner	300
Deep fat fryer, food	1,000 pounds per hour	15,000	do	1,500
Delayed coker unit	9,300 barrels per day	4,000,000	Scrubber (serving 3 cokers).	385,000
Drum reclamation incinerator	60 barrels per hour	10,000	Afterburner	2,000
	200 barrels per hour	25,000	do	5,000
Electric arc furnace, steel	18 tons, heat	75,000	Baghouse	45,000
Electric induction furnace, brass.	2,000 pounds per hour	75,000	do	2,700
Enamel frit drying	1,500 pounds per hour	25,000	do	3,000
Fiberboard production	32,000 pounds per hour	10,000	Electric precipitator.	15,000
Fire-retardant manufacturing	1,000 pounds per hour	25,000	Baghouse	2,000
Fixed roof storage tank for gasoline.	80,000 barrels	50,000	New floating roof tank.	132,000
Flue-fed incinerator	Most sizes	4,000–7,000	Afterburner	2,500
Fluid catalytic cracking unit	40,000 barrels per day	7,460,000	Electric precipitator.	1,040,000
			CO boiler	1,770,000
			Cyclones	165,000
			Blowdown systems, vapor manifold, and flare.	363,000
	7,400 barrels per day	1,747,500	Electric precipitator, vapor manifold, and flare.	131,000
Galvanizing kettle	4 by 30 by 4 feet	25,000	Baghouse	3,000
Gritblasting machine	6 cubic feet	9,300	do	1,700
Insecticide manufacturing	1,000 pounds per hour	10,000	do	3,000
Insulation production, including cupola, blow chamber, and curing oven.	5,000 pounds per hour	13,000	Baghouse, scrubber, and afterburner.	30,000
Liquid hydrogen manufacturing.	32 tons per year	8,392,000	Flare	17,700
Lithographing oven	240 feet per minute	78,000	Afterburner	15,000
Multiple-chamber incinerator, industrial and commercial.	50 pounds per hour	800		
	500 pounds per hour	6,500		
	6,000 pounds per hour	75,000		
Multiple-chamber incinerator, pathological.	50 pounds per hour	1,000		
	200 pounds per hour	4,500		
Multiple-chamber incinerator, wire reclamation.	100 pounds per hour	1,200		
	1,000 pounds per hour	15,000		
Multiple-chamber incinerator, with continuous feed bin.	250 pounds per hour	5,000		
	3,000 pounds per hour	45,000		
Natural gas plant	20,000,000 cubic feet per day	220,000	Vapor manifold and flare.	5,000
Oil-water separator	300,000 barrels per day	170,000	Floating roof	80,000
	350 barrels per day	17,000	Cover	700
	3,500 barrels per day	32,000	Floating roof	8,000

TABLE 5.—*Typical costs of basic and control equipment installed in Los Angeles County*—Continued

Source	Size of equipment	Cost of basic equipment	Type of control equipment	Cost of control equipment
Open hearth furnace, steel	60 tons, heat	200,000	Electric precipitator	150,000
Phosphate fertilizer production	2,000 pounds per hour	10,000	Baghouse	5,000
Phthalic anhydride manufacturing plant	25,000,000 pounds per year	1,200,000	Afterburner and baghouse	195,000
Pipe coating, lapping, spinning, wrapping, and dipping	4–10 lengths per hour	28,500	Stackers	32,000
Pneumatic conveyors, multicyclone	200 to 5,000 pounds per hour	2,000	Cyclone and baghouse	2,000
Pot furnaces, type metal	16,000 pounds	9,000	Afterburner	3,000
Rendered grease processing	6 tons per day	10,000	Contact condenser and afterburner	2,500
Rendering cooker and drier (batch)	4 tons per batch	10,000	Surface condenser and afterburner	15,000
Rendering cooker system, continuous	15 tons per hour	100,000	do	25,000
Rock crushing and sizing	300,000 pounds per hour	75,000	Scrubber	2,000
Rotogravure press	5-color, 44-inch web	340,000	Activated carbon filter	40,000
Rubber Banbury mixer	1,000 pounds per hour	25,000	Baghouse	3,000
Sand cast room	8 by 12 by 8 feet	1,000	do	5,000
Sewage treatment digestion	800,000 gallons per day	800,000	Water seals and flares	7,000
Sewage treatment, new works	250,000,000 gallons per day	500,000	Covers	20,000
Sewage water reclamation	17,500,000 gallons per day	1,500,000	Covers and auxiliaries	25,000
Sewer pipe manufacturing	20,000 pounds per hour	1,000,000	Baghouse	10,000
Ship block riveting	2,500 tons per year	500,000	do	100,000
Smoke generator and smokehouse	11 by 14 by 11 feet	18,000	Precipitator, separator, and afterburner	42,000
Sulfuric acid plant	250 tons per day	1,900,000	Electric precipitator	150,000
Sulfur recovery plant	2 parallel units, 65 tons per day, each	1,400,000	Incinerator	30,000
	10 tons per day	265,000	do	5,000
	2,840 pounds per day	30,000	do	1,000
	5,000 pounds per day	60,000	do	1,000
Sweat furnace, aluminum	3,000 pounds per hour	5,000	Afterburner and baghouse	5,000
Synthetic rubber manufacturing	36,000 tons per year	1,000,000	Various combustion and flare	200,000
Synthetic solvent dry cleaner	60 pounds per batch	14,000	Activated carbon filter	5,000
Varnish cookers (2)	250 gallons each	4,000	Afterburner	5,000
Wallboard production	90,000 pounds per hour	1,500,000	Baghouse	100,000

[1] Each

The true price of control equipment is often difficult to determine. In some cases, the control system is tied into production changes. In others, the equipment serves to reclaim valuable materials which had been escaping. In still others, the controls are an integral part of a new installation and their cost cannot be accurately estimated.

Further research and experience with existing control systems will lead to greater collecting efficiencies and lower costs. The evidence is conclusive, however, that in the great majority of situations, where required, the technical know-how exists.

Solutions also exist for many important nonindustrial sources of air pollution. Open-burning dumps, the use of inadequate municipal incinerators, leaf burning, the open burning of scrapped automobiles, insulated wires, battery cases and tires—all of these can be controlled.

Increasingly widespread enforcement of smoke-abatement ordinances has proved that smoke pollution from domestic, commercial, and industrial incinerators, boilers, and heating systems can be largely eliminated. Accomplishing this may require limitations on permissible fuel quality, improved stoking and combustion equipment, and education as to proper firing practices.

CHAPTER VI—STANDARDS FOR AIR POLLUTION CONTROL

Attempts to set standards to limit the release of pollutants into the atmosphere have traditionally followed an empirical approach, based on the dual considerations of engineering feasibility and economic acceptability. Following this course, air pollution control programs in several of the larger American cities have developed emission limitations which affect for the most part the more obvious sources of smoke and, to a lesser degree, other sources of particulate pollution. Admittedly crude, but practical, techniques for measuring the output of visible pollutants were developed for purposes of enforcement—the most widely employed being the Ringelmann chart, a graduated spectrum against which the density of particulate pollution from a single source is estimated.

At the same time, standards were established to regulate the use of fuels to help curtail the release into the air of smoke, fly ash, and other particulate pollutants. To the extent that some of these regulations limited the use of fuels with high sulfur content, gaseous emissions in the form of oxides of sulfur were also somewhat curtailed.

These standards were applied to individual sources of pollution but, as sources multiplied and the entire picture of source emissions became more complex, it became apparent that emission limitations which were applied only to certain obvious sources were inadequate for effectively insuring the quality of the ambient air in an entire community.

In many cases the techniques and procedures employed to determine and enforce emission limitations were considered objectionable by the those officially responsible for the control of air pollution as well as by those responsible for the sources subject to such control.

These considerations have led to the recognition that an arbitrary approach to the development of air quality standards would have to give way to a rational approach that is based not only on the readily attainable but also—in terms of known and suspected effects of air pollution—on what is necessary for the protection of human health and welfare.

An organized scientific appraisal of the medical, social, and economic problems posed by air pollution has been underway for only about a decade. Most State and local control agencies have not yet determined the dimensions of their air pollution problems and have not adequately controlled many obvious sources of pollution. Nevertheless, the basic question of to what degree air must be cleaned must be answered. While the question is simple, the answer, which involves inevitably the promulgation of air quality standards, is complex.

Whether or not the lack of ambient air quality standards has seriously hindered the progress of control efforts, there is merit in the arguments of those who contend that, in the absence of standards, control programs are obliged to work partly in the dark and that those

responsible for source emissions lack firm goals toward which to strive. The rational approach to air quality control would involve, first, a determination of the degree of ambient air quality desired; second, ambient air standards to determine the degree and kinds of control effort needed to insure adequate air quality; and, third, the development and enforcement of emission limitations to insure that individual sources are sufficiently curtailed so that emissions from the aggregate of sources do not exceed any provision of the ambient air standards.

Ambient air standards can most realistically be developed with reference to air quality guidelines in the form of air quality criteria, developed in the light of the best available technological and scientific judgments. In the development of air quality criteria, consideration is given to the dual factors of pollution concentrations and exposure times as these in combination cause specific effects on man, animals, vegetation, and other aspects of the environment. There are many kinds of such effects to be considered—including health, sensory irritation, and damage to animals, to ornamental plants, and to agricultural crops. In addition, consideration must be given to such matters as reduction of visibility, soiling and corrosion of fabrics, metals, and other materials, and possible effects on weather.

The same concentrations of specific biologically active pollutants are, in general, no less hazardous in one city than another, no matter to what extent the air pollution problems may differ in other aspects. Therefore, it is appropriate that State and local agencies look to the Federal Government for guidance which the Federal Government can provide by developing air quality criteria. The Federal air pollution program has the resources, the experience, and the perspective to provide national leadership in this area as it has in air pollution research, technical assistance, training, and information dissemination. The Federal program should develop and promulgate air quality criteria formulated upon the best knowledge available today and subject to review and modification as new knowledge dictates. These criteria would constitute comprehensive guides to which local and State agencies would refer in establishing their ambient air standards.

Standards for public protection have been successfully developed in many areas of modern industrialized life. Standards for the purity of foods and drugs and for water have resulted both from a recognized need and from the fact that these materials can be made safe for use before they reach the individual whose health depends upon their purity. While the need for standards in air has also recently become recognized, the fact that the community air cannot be treated or purified prior to use underscores the importance of the proper control of sources of pollution. Water taken from virtually any river would be dangerous to drink if it were not purified before use. The intake of air pollutants, on the other hand, which are present in the ambient atmosphere, cannot be avoided by the individual citizen.

The numbers, magnitudes, and types of sources, meteorological factors, and other variables affecting air quality in different geographic locations, vary considerably. These differences mean that emission limitations developed to insure air quality may differ somewhat from community to community and from State to State. For this reason,

it is appropriate that local control agencies establish emission limitations in the light of local conditions.

In the case of interstate air pollution problems, ambient air quality standards developed by one community have a direct bearing on the quality of the air in an adjacent community located in another State.

In the event that standards established by a community are not sufficiently stringent to prevent damage to another community in a different State, it may be necessary to establish enforcement procedures to require compliance with adequate standards. In such cases the only recourse available in interstate pollution problems is through Federal legislation.

Because of imperfections in the status of scientific knowledge and changing technology ambient air standards should not be regarded as immutable. Control agencies will have to be sufficiently flexible in their regulatory activities to readily adapt to accepted air pollution criteria which will change in the light of new problems, new knowledge, and new opportunities for the control of air pollution.

There will be instances where some control agencies will find it desirable to establish ambient air standards that are considerably more stringent than those in other locations.

For example, a community in a resort area may determine that a degree of atmospheric clarity greater than that achieved by most cities is essential to its economic well-being. In such a case, it would no doubt establish emission limitations to insure a lower degree of visibility interference than might be required in other cities.

Only a small percentage of the States have statutory control programs, and most of these are very new and based on limited experience. With few exceptions—such as the States of California and Oregon, where a beginning has been made in the promulgation of air quality standards—most control programs are operating on a more or less arbitrary approach which tends to equate the acceptable with the readily attainable.

Air quality standards cannot be developed and applied effectively unless the control agency has detailed and continuing information about ambient air pollutant concentrations and about the sources of pollution in its area of jurisdiction. These data should be augmented by continuing information on the meteorology of the area. There are but few agencies currently able to arm themselves with such data because of budgetary and technical manpower insufficiencies. If the advantages of the rational approach to the control of air pollution are to be realized, these fundamental deficiencies in control agency financial support and staffing must be corrected.

CHAPTER VII—A LOOK INTO THE FUTURE

It is obvious that current efforts are not on a scale adequate to contain air pollution even within its present unsatisfactory levels. The number of localities with significant problems, and the severity of such problems, are bound to increase with a steadily growing population, producing and consuming an ever-increasing amount of energy and products. The following table gives an estimate of the increase between 1950 and 1960 of the number of urban places with air pollution problems and of the population exposed.

Estimated increase in urban places with air pollution problems and people exposed to pollution (urban places of 2,500 or more population)

[Population in thousands]

Year	Type of urban pollution problem and number of people exposed							
	Major problem		Moderate problem		Minor problem		All problems	
	Number of places	Number of people	Number of places	Number of people	Number of places	Number of people	Number of places	Number of people
1950	224	36,710	636	22,450	1,407	21,920	2,267	81,080
1960	308	42,940	847	30,160	1,818	31,200	2,973	104,300
Increase, 1950–60	84	6,230	211	7,710	411	9,280	706	23,220

The increase in population between 1960 and 1970 will be equal to the combined 1960 populations of the States of New York and California. At least 25 million more people, according to present trends, will be living in urban areas by 1970. The added pollution burden represented by this additional population, if inadequately controlled, could bring about a degeneration of air quality to the point where episodes of acute illness and even deaths were more than occasional. Accompanying this, undoubtedly, would be a continuation of the steadily increasing incidence of various types of chronic respiratory disease now being observed. Inevitably, the extent of damage to structures, crops, and other property would increase as well, with a decrease in area of land acceptable for residential, agricultural, or recreational use. This loss of land use is of great economic significance, since it increases the cost of the remaining acceptable land.

To prevent such a situation from developing, several courses of action merit consideration.

The expansion and acceleration of research efforts in all major aspects of the air pollution problem has been recommended as essential. Such recommendations have been recently emphasized in reports from several distinguished groups which have conducted detailed reviews and evaluations of national efforts to cope with the modern environment. Such groups, with representation from industry, State and local governments, and educational institutions, have included the

National Academy of Sciences—National Research Council Committee on Atmospheric Sciences, the Surgeon General's Ad Hoc Task Group on Air Pollution Research Goals, and the Surgeon General's Committee on Environmental Health Problems. These reports point out the need and responsibilities for research by industry, and by States and communities, as well as by the Federal Government.

The development of air quality criteria deemed necessary to protect the public health and welfare is also required as a basis for selecting the standards to be employed. An important use of research findings will be in the formulation of such criteria.

In addition there is a need to strengthen the control programs of States and communities, since existing control authority rests solely with them. While there are exceptions, in general it can be said that such programs have three unsatisfied basic needs, which must be met in order to carry out their missions effectively: (1) sufficient funds and adequate salary scales, (2) appropriate adequate legal authority, and (3) public understanding and support.

Legislative proposals have been made to provide financial assistance to State and local air pollution control agencies through a Federal grants program. It is quite evident that budgetary support for the overwhelming majority of existing programs is completely inadequate. If the situation is allowed to deteriorate further the ultimate cost will be much greater.

Local jurisdictions do not always have the necessary authority to adopt such regulations as are needed to control pollution originating within their own boundaries. Even where they do, however, attainment of satisfactory air quality frequently requires control of pollution sources outside of the political boundaries of the community—sometimes even from another State. Solution of such problems requires, first and most importantly, a willingness to cooperate, on the part of the areas where such pollution arises, plus legal authority to establish necessary control powers in an existing agency or in a special one created for the desired purpose. The overall record, to date, on the control of multijurisdictional air pollution problems, has not been particularly encouraging.

Public understanding and support are essential for the successful control of the rapidly intensifying problems of air pollution. It was clearly demonstrated at the 1962 National Conference on Air Pollution that there is widespread concern about air pollution and a consensus that a greater control effort is needed now. The question to be resolved is how this should be accomplished.

APPENDIXES

Appendix I

Summary of Responses by States to Mail Questionnaire of April 30, 1963, on Air Pollution Sent by Senator McNamara, Chairman, Senate Public Works Committee

I. INTRODUCTION

On April 30, Senator Pat McNamara, chairman of the Senate Public Works Committee, sent letters to the Governors of all the States and territories requesting them to answer a set of seven questions on the status of air pollution control legislation in their respective jurisdictions and soliciting their opinions on certain proposed Federal activities in the field, the answers to be used in preparing a staff report on the subject of air pollution control. By August 15 replies had been received from 51 of the States and territories; only Kansas, Louisiana, and Minnesota had not yet replied.

II. QUESTION-BY-QUESTION ANALYSIS

1. "Does your State have air pollution control laws? If so, would you give a brief digest of their principal provisions?"

Thirty-three of the responding units had such laws; 18 did not. Five States, Connecticut, Colorado, Maryland, North Carolina, and Utah, had passed significant air pollution control legislation during their 1963 legislative sessions.

The responses to the second half of this question (i.e., give a brief digest) varied greatly in approach and content. For purposes of analysis, States having laws were placed into three categories:

(1) Control authority, with or without other provisions (15 States);

(2) No control authority, but local option legislation, with or without research and technical assistance authority (12 States);

(3) Research and technical assistance authority only (6 States).

(See tables for breakdown.)

2. "If your State does not have air pollution control laws, is it contemplated that such laws may be enacted?"

Of the 18 units having no air pollution control laws, 10 (Arkansas, Georgia, Maine, Michigan, Montana, New Mexico, Texas, Virginia, Puerto Rico, and the Virgin Islands) indicated some interest in promoting such legislation. Three States (Arkansas, Montana, Virginia) reported having studies of the problem underway, with a view to eventual framing of appropriate laws. Five (Georgia, Maine, Michigan, New Mexico, Texas) related previous, unsuccessful attempts to pass air pollution legislation, but added that efforts in this direction continue.

Eighteen of the thirty-three units already having air pollution laws followed the instructions and ignored question 2. Of the other 14, 5 asserted satisfaction with their present laws; 3, having at present control authority, are engaged in critically reviewing existing legislation; 4 have local option laws at present, and of these, 2 (Illinois, Kentucky) expressed real optimism concerning the passage of control legislation; 1 (Colorado) has a research law and is studying the need for more general legislation in the field.

3. "Do you have air quality standards and emission standards? If so, what measures are taken to obtain enforcement or compliance?"

California has established statewide air quality standards, enforcible by local districts, and motor vehicle emission standards enforcible at the State level; Oregon has quality and emission standards enforced through hearings before the State sanitary authority; New York is in the process of establishing air quality standards. No other States have gone as far in this field, although the establishment of such standards is reported to be authorized by statute in

Alaska, Colorado, Indiana, Washington, and West Virginia (and for quality only in Maryland and Pennsylvania).

Several units have emission standards for one or a few pollutants:

District of Columbia: Prohibits automobile exhaust emissions as dark or darker than Ringelmann No. 2 and enforces this by periodic inspection;

Florida: Limits smoke emission density to Ringelmann No. 2 and has limits for fluoride emission;

Hawaii: Has standards for visible emissions, enforcible through legal proceedings;

New Jersey: Limits smoke density to Ringelmann No. 2, and in addition has standards for permissible levels of fly ash emission, stated in pounds per hour.

4. "Do you have air pollution problems in your State which arise from sources outside your State? If so, do you have agreements with neighboring State or States to deal with the problem, and what provisions are made to handle the matter?"

Nineteen units reported air pollution problems originating outside their jurisdiction, while 29 said they had none. Generally, the States with such problems tended also to have control authority of their own. Six States reported the existence of formal or semiformal mechanisms dealing with interstate air pollution problems:

> New Jersey and New York work toward the solution of their joint problems through the air pollution branch of the Interstate Sanitation Commission, which makes technical studies and recommends action to the Governors and legislatures, and through the New York-New Jersey Cooperative Committee for the Control of Interstate Air Pollution, which is designed to "discuss and plan activities for the control of interstate air pollution."
>
> Michigan noted the existence of the United States-Canada International Joint Commission as a medium for discussion of air pollution problems in the Detroit River area.
>
> District of Columbia participates with nearby local governments in Maryland and Virginia in special air pollution committees of the Metropolitan Washington Council of Governments.

Five States (Indiana, Ohio, Oregon, Vermont, Washington) reported having made some attempt to cope with this problem by working along more informal, cooperative lines. Delaware, which has an unresolved interstate problem with Maryland, suggested that "when interstate problems occur and one State has no air pollution control power it would appear that Federal legislation should be available so that either State may apply through its Governor for assistance in the solution of such a problem."

5. "Does your State have a State-financed program of air pollution control research?"

Ten States have legislation authorizing air pollution control research, but only three, California (which spends $800,000 a year for this purpose), New Jersey (which has spent $250,000 over the past 9 years), and New York reported conducting fairly extensive programs. Many replies mentioned the need for Federal leadership in research; those from California, Delaware, Iowa, Massachusetts, West Virginia, and Wisconsin especially stressed this aspect of the Federal role in the field of air pollution.

6. "Would it be helpful to your State if the Department of Health, Education, and Welfare would recommend air quality standards and emission standards and assist in obtaining compliance with such standards?"

This is a three-part question. With respect to air quality standards, 37 units said "Yes," 1 said "Yes" with qualifications, and only 12 "No." Concerning emission standards, 35 said "Yes," 1 "Yes" with qualifications, and 12 "No." All but two of the units responding to both parts either favored both proposals or rejected both. New York, a State with comprehensive control programs, said "Yes" to quality standards and "No" to emission standards, stating that State-to-State variation in pollution levels makes the establishment of emission standards more properly a local function; Virginia, which has no law at all, said exactly the reverse, without giving reasons. Here again the importance of the Federal role in research was stressed; several letters suggested that the United States concentrate on developing criteria for evaluating air pollution and leave the actual standard setting to the States. Among these were California, Massachusetts, Ohio, Oregon, Texas, and Washington.

The replies were less receptive to the suggestion of Federal participation in the enforcement of air pollution control standards. Of those responding, 19 said "Yes," but 9 of these had more or less extensive qualifications, and 23 said "No." An interesting aspect of the response to this part of the question is the fact that units already having control authority of their own were generally less receptive to Federal aid in enforcement than the units without such laws.

7. "General suggestions on how to cope with air pollution."

The responses to this question were generally not very extensive, but some did provide interesting insights into State thinking on various aspects of air pollution control.

Some of the more interesting suggestions were:

Alaska:[1] Federal assistance along lines of water pollution would be beneficial.

Arizona (and Michigan and Nebraska):[1] Praises free cooperation approach to control.

Arkansas:[2] Primary control authority should rest with States; air pollution program should be in State health agency.

California:[1] Motor vehicle emission control should receive highest priority from Federal Government: Control emissions from present-day automobiles, but long-range objective to design pollution-free engines, use rapid transit systems, and proper city planning.

Colorado:[2] All Federal-local negotiations and activity should be through State health department.

Connecticut:[2] Federal grants to States should be on a formula, rather than a project basis, so as to avoid "grantsmanship" and tailoring one's program to meet the whims and fashions of Federal grant administrators.

Florida:[3] Interested in research on removal of sulfur from fuels, and in the development of inexpensive sampling and analytic equipment. Feels that all grants to localities should be processed through State air pollution agency.

Hawaii:[1] Desire Federal program and training grants to States and stronger emphasis on research on Federal level.

Indiana:[1] Should require approval of State air pollution agency before grants are made to localities.

Iowa:[2] For local or interlocal control; State control action only on request or where local government fails to act; Federal control action only when requested by State or in interstate problems after consultation with offending State.

Kentucky:[3] Encourages extension of Federal program of grants for program establishment, training, and research.

Maine:[1] For interstate cooperation; Federal role should be research and technical assistance.

Maryland:[3] Doubts that universally satisfactory air quality will ever be achieved; for application of controls, where economic conditions permit, to obtain a reasonable air quality level.

Michigan:[1] For cooperative efforts between State and local units of government and industrial sources.

Missouri:[2] Air quality and emission standards should be set at the local level.

Nebraska:[1] With reasonable amount of encouragement, industry will fulfill its obligations.

New Hampshire:[3] Federal Government should limit itself to a research and advisory role.

New Jersey:[1] Research directed toward technical and rulemaking methodology most essential; cost should primarily fall on Federal Government.

New Mexico:[1] Essential to learn more about effects and control; standards should be developed and adopted by all States; looks forward to State legislation to control present air pollution situation before it becomes a statewide problem.

New York:[3] Air pollution is a national problem only in that such problems are found nationwide; but they differ in cause and effect.

North Carolina:[2] For local control with technical guidance from State and Federal Government and Federal financial assistance.

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[1] Reply signed by Governor.
[2] Reply signed by State health officer.
[3] Reply signed by other State official.

Oregon: [1] Great need is to awake people to the problem and make them realize its control is a community function. Stimulate local action by program grants and better definition and publicizing of the actual economic costs of air pollution.

Pennsylvania: [1] Federal Government can assist States through technical and financial assistance and research (especially burning culm piles).

Rhode Island: [2] Air pollution not well understood; need more research.

South Dakota: [3] Air pollution in State does not warrant full-time staff at State level; welcomes specialist consultation for isolated problems.

Tennessee: [2] Impressed with complaints from rural areas or small towns about point sources; application of controls and how they are to be financed is the problem.

Texas: [3] Need for research on standards and on biological effects of air pollution stressed.

Utah: [1] State and local efforts sufficient to control air pollution; no need for Federal participation in enforcement.

Vermont: [1] Wants technical assistance to aid local solving of local problems, and recommendation of methods for obtaining compliance.

Virginia: [2] Problem of inability of State to provide technical assistance to communities with air pollution problem since no statutory responsibility exists.

Wisconsin: [1] Advises Federal loans for the construction of control facilities, and tax amortization acceleration for such facilities.

III. CONCLUSION

Most States seem to be wary of direct Federal action in air pollution control, but admit their own inadequacy in the fields of research, including the development of criteria for standards of air quality, and seem to favor expanded Federal action in these areas.

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[1] Reply signed by Governor.
[2] Reply signed by State health officer.
[3] Reply signed by other State official.

Summary of responses by States to mail questionnaire of Apr. 30, 1963, on air pollution sent by Senator McNamara, Chairman, Senate Public Works Committee

GENERAL COMPILATION TABLES

State [1]	Officer responding [2]	Type of air pollution law [3]	Replies to questions [4]		
			New air pollution legislation planned	Existing air quality and emission standards	Interstate air pollution problems
Alabama	HO	0	N	N	N.
Alaska	G	1	Y	N	N.
Arizona	G	2	NA	N	N.
Arkansas	HO	0	Y	N	N.
California	G	1	NA	Y	N.
Colorado	G	3	Y	N	NA.
Connecticut	HO	3	N	N	N.
Delaware	HO	1	NA	N	Y.
District of Columbia	G	1	Y	Y	Y.
Florida	HO	1	NA	Y	N.
Georgia	HO	0	Y	N	N.
Hawaii	G	1	NA	Y	N.
Idaho	HO	1	NA	N	N.
Illinois	HO	2	Y	N	Y.
Indiana	G	1	NA	N	Y.
Iowa	HO	2	N	N	N.
Kentucky	O	2	Y	N	Y.
Maine	G	0	Y	N	Y.
Maryland	O	1	NA	N	Y.
Massachusetts	O	1	NA	Y	N.
Michigan	G	0	Y	N	Y.
Mississippi	HO	0	N	N	N.
Missouri	HO	2	N	N	Y.
Montana	G	0	Y	N	N.
Nebraska	G	2	Y	N	N.
Nevada	G	2	N	N	N.
New Hampshire	HO	0	N	N	N.
New Jersey	G	1	NA	Y	Y.
New Mexico	G	0	Y	N	Y.
New York	O	1	NA	Y	Y.
North Carolina	HO	3	NA	N	NA.
North Dakota	O	0	N	N	N.
Ohio	O	3	NA	N	Y.
Oklahoma	O	3	N	N	N.
Oregon	G	1	NA	Y	Y.
Pennsylvania	G	1	Y	N	Y.
Rhode Island	O	2	Y	N	N.
South Carolina	HO	2	Y	N	NA.
South Dakota	HO	0	N	N	N.
Tennessee	HO	3	NA	N	N.
Texas	HO	0	Y	N	N.
Utah	G	2	NA	N	N.
Vermont	G	0	N	N	Y.
Virginia	HO	0	Y	N	Y.
Washington	HO	2	NA	N	Y.
West Virginia	G	1	NA	N	Y.
Wisconsin	G	2	N	N	N.
Wyoming	O	0	N	N	N.
Guam	G	0	N	N	N.
Puerto Rico	HO	0	Y	N	N.
Virgin Islands	G	0	Y	N	N.

[1] States not replying were: Kansas, Louisiana, Minnesota.

[2] Key: G—Governor; HO—State health officer; O—Other official.

[3] Key: 0—no State air pollution laws; 1—control authority, with or without local option and research and technical assistance authority; 2—no control authority but local option legislation, with or without research and technical assistance authority; 3—research and technical assistance authority only.

[4] Key: Y—yes; N—no; NA—no answer.

Summary of responses by States to mail questionnaire of Apr. 30, 1963, on air pollution sent by Senator McNamara, Chairman, Senate Public Works Committee—Continued

State	Research program authorized	Replies to questions: HEW assistance desirable in—		
		Formulation of air quality standards	Formulation of emission standards	Obtaining compliance with standards
Alabama	N	Y	Y	NA.
Alaska	N	Y	Y	Y
Arizona	Y	N	N	N
Arkansas	N	N	N	N
California	Y	N	N	N
Colorado	Y	Y	Y	N
Connecticut	N	Y	Y	Y
Delaware	N	Y	Y	Y
District of Columbia	N	Y	Y	Y
Florida	N	Y	Y	NA.
Georgia	N	Y	Y	N
Hawaii	N	N	N	N
Idaho	N	Y	Y	NA
Illinois	N	N	N	N
Indiana	N	Y	Y	N
Iowa	N	Y	Y	Y
Kentucky	N	N	N	N
Maine	N	Y	Y	Y
Maryland	Y	Y	Y	Y
Massachusetts	N	N	N	N
Michigan	N	N	N	N
Mississippi	N	Y	Y	Y
Missouri	N	Y	Y	NA.
Montana	N	Y	Y	Y
Nebraska	N	Y	Y	NA.
Nevada	N	Y	Y	Y
New Hampshire	N	Y	Y	NA.
New Jersey	Y	Y	Y	N
New Mexico	N	Y	Y	Y
New York	Y	Y	N	Y
North Carolina	N	Y	NA	NA.
North Dakota	N	NA	NA	NA.
Ohio	Y	N	N	N
Oklahoma	N	Y	Y	Y
Oregon	Y	Y	Y	N
Pennsylvania	N	Y	Y	N
Rhode Island	N	Y	Y	N
South Carolina	N	Y	NA	NA.
South Dakota	N	Y	Y	Y
Tennessee	N	Y	Y	Y
Texas	N	N	N	N
Utah	N	Y	Y	N
Vermont	N	Y	Y	Y
Virginia	N	N	N	N
Washington	Y	N	N	N
West Virginia	N	Y	Y	N
Wisconsin	N	Y	Y	N
Wyoming	N	Y	Y	N
Guam	N	Y	Y	Y
Puerto Rico	N	Y	Y	Y
Virgin Islands	N	Y	Y	Y

Note.—N—No
Y—Yes
NA—No answer.

Appendix II

Brief Digests of State Air Pollution Laws

Introduction

The legislation enacted by the various States to meet the air pollution problem presents a broad range of approaches. In most cases where the State has actual control authority, there is provision in the legislation which recognizes local interests and responsibilities and permits local governments to enact more stringent requirements. Thus far there are 15 States which have legislation of this type. In addition, 12 States have enacted enabling legislation, which although variable in detail and extent, permits the establish-

ment of programs for control at a local level of government. At least six States have provided the mechanism for conducting research and making technical assistance available to the local governments. A growing number of States have recognized the financial burden placed on industry in meeting the requirements for air pollution control and six States have either exempted such facilities from taxation or have provided for rapid tax amortization. The development of standards for either emissions or ambient air quality is gathering considerable momentum and at least 14 States have such authority in their legislation. However, widespread progress in this area is quite limited at this time. A review of existing State air pollution legislation does reveal general similarities in objectives, but considerable variation in the means of attaining them, either through content, organizational structure, or procedure.

Alaska.—Under the general enabling statute for the department of health and welfare, Alaska has developed a more detailed administrative code relative to air pollution. The commissioner of health and welfare is empowered to establish air quality standards, conduct enforcement proceedings, and institute legal proceedings to compel compliance with his orders, grant (and revoke) permits to potential air pollution-creating installations, require the submission of plans for air pollution control by any industrial establishment or property development, engage in cooperative activities, and represent Alaska for the receipt of moneys for air pollution control.

Arizona.—A county board of supervisors has authority to investigate and control air pollution within its jurisdiction, including the authority to adopt rules and regulations and to establish an air pollution control district for this purpose if it so desires.

California.—Enabling laws have been passed that permit the formation of air pollution control districts in all counties and establish a regional air pollution control district in the San Francisco Bay area. Local districts of this kind are given broad powers to adopt and enforce rules and regulations on the control of pollutants from stationary sources.

The State department of public health is authorized to study the health effects and the nature and occurrence of air pollution, assist local agencies, monitor air pollutants, and adopt standards for air quality and for motor vehicle emissions.

The State motor vehicle pollution control board has the responsibility for testing devices, approving those found to meet the standards established by the department of public health, and setting up schedules for the adoption of any such device when two or more of the same type have been approved.

The department of motor vehicles is authorized to license and supervise the operation of motor vehicle pollution control device inspection stations.

Cost of equipment installed for the purpose of controlling air pollution may be deducted from income for tax purposes, and the cost of such equipment may be amortized over a 60-month period.

Colorado.—The two primary objectives of the Colorado law are:

(1) The development by early 1964 of standards of air quality and standards for motor vehicle pollution control devices; and

(2) The identification of the geographic areas in which air pollution is occurring. The State board of public health, aided by the advice of air pollution advisory committee appointed by the Governor, is charged with the primary responsibility for meeting the objectives.

Connecticut.—The commissioner of health is empowered to engage in research and in cooperative and educational activities relative to the control of air pollution, and to accept and administer Federal grants and other gifts.

Delaware.—The air pollution authority, administered by the State board of health, is empowered to develop a comprehensive pollution control program, conduct studies, investigations, and research relating to air pollution and its causes, promulgate rules and regulations and issue orders, encourage voluntary action to control air pollution, and represent the State in dealings relative to interstate compacts for air pollution control.

District of Columbia.—There now exist scattered laws and regulations relative to the control of emissions from motor vehicles, smoke emission, dusts, and noxious odors and gases. Further, responsibility for the coordination and development of a comprehensive air pollution control program has been placed, by a recent reorganization order, on the Director of Public Health.

Florida.—The air pollution control commission, established in the State board of health, is empowered to promulgate rules and regulations for the

control of air pollution, establish air pollution control districts within the State, and provide technical services. The State board of health is authorized to enforce the commission's rules and regulations and to engage in research and educational and cooperative activities. Alachua, Broward, Brevard, St. Lucie, and Sarasota Counties have air pollution control authority established by specific State laws.

Hawaii.—The State director of health is authorized to adopt rules and regulations controlling air pollution, designate specific geographical areas to which these will apply, establish a section of air pollution control in the State department of health, conduct and supervise research programs on air pollution, authorize the issuance of permits to control pollution, enter and inspect premises to conduct tests, hold hearings on air pollution complaints, organize county advisory air pollution associations, and conduct programs on air pollution control education.

Idaho. The air pollution control commission in the State board of health has authority to engage in research and educational and cooperative activities, to adopt and enforce rules and regulations relative to air pollution, and to organize county units for the local study of air pollution problems. The board of health is required to cooperate with the commission and to police air pollution pursuant to its rules and regulations.

Facilities or equipment used to control air pollution, in such proportion as they have no other beneficial purposes, are exempted from taxation.

Illinois.—Cities and counties have authority to pass ordinances regulating air pollution within their jurisdictions, including authority to abate any active pollution and to specify the use and design of equipment which emits air contaminants.

The air pollution control board may pass rules and regulations, including the regulation of new equipment potentially productive of air pollution, and may act to enforce them, by making investigations, holding hearings, and instituting legal proceedings. The board is directed to encourage voluntary cooperation with its air pollution control goals, and to offer and render technical assistance to lower level control agencies. Further, it is empowered to engage in research and educational and cooperative activities, to grant variances, and to grant certificates of exemption from State enforcement authority to those localities which have air pollution control programs not inconsistent in intent and operation with those of the State.

Indiana.—The air pollution control board within the State board of health is empowered to adopt and promulgate reasonable rules and regulations, make investigations, enter orders to abate air pollution, and bring appropriate legal action to enforce its final orders or determinations. The State board of health is directed to provide the staff for the air pollution control board, promote air pollution control ordinances and activities in local communities, provide technical assistance, provide assistance to areas unable to afford an air pollution control program, and resolve cases outside the jurisdiction of local control agencies. State enforcement authority does not extend to those areas which already have effective laws of their own that are consistent with the requirements of the State law.

Iowa. Statutes provide for limited air pollution control by municipalities, but not by any State agency.

Kentucky.—Air pollution control districts, activated by resolution of the appropriate county fiscal court, are empowered to make rules and regulations for the control of air pollution within their boundaries, and to enforce them with the help of their appointed officers and a hearing board. A district may require permits for all potentially pollution-creating operations.

Maryland.—The State board of health and mental hygiene is authorized to adopt rules and regulations and to enforce them, and to engage in educational, cooperative, and research activities. The air pollution control council is primarily advisory to the board but is also specifically directed to make recommendations for adoption of rules and regulations and changes therein, to conduct hearings prior to the adoption of such rules, and to prepare recommendations for individual exceptions thereto.

Massachusetts.—City authorities may pass air pollution control regulations, subject to approval by the State department of health, which may also adopt and amend regulations and assume direct jurisdiction in the case of interstate air pollution.

A metropolitan air pollution control district which comprises Boston and contiguous towns controls air pollution within its borders, as agent of the department, by establishing and enforcing rules and conducting field studies. Other similar districts may be formed by two or more contiguous political units on joint application to, and approval by, the department.

Equipment on real property used to control air pollution is exempt from taxation.

Missouri.—The powers delegated by the legislature to municipalities include the authority to control, and require the abatement of, nuisances and to control the emission of smoke.

Montana.—An interim air pollution investigating committee composed of seven Montana residents appointed by the Governor, established in 1963, is directed to study the nature, character, and extent of air pollution in the State and in its various communities, and to report, without recommendation, to the 1965 session of the legislature.

Nebraska.—The State authorizes cities of 150,000 or more inhabitants to provide by ordinance for smoke abatement.

Nevada.—Boards of county commissioners and cities within the county may cooperate for the control of air pollution through joint use of personnel, equipment, and facilities.

New Hampshire.—The State provides a limited tax exemption for devices and installations put in operation for the purpose of controlling air pollution.

New Jersey.—The air pollution control commission has responsibility for developing rules and regulations for the control of air pollution. The State department of health is authorized to enforce these, and is further empowered to engage in research and educational and cooperative activities, to require the registration of potential air pollution-creating operations and the filing of reports, to inspect buildings other than private residences, to process complaints, to hold hearings, and to institute legal proceedings. Penalties are provided for violations.

New York.—The air pollution control board in the State department of health is empowered to adopt and enforce rules and regulations, promulgate quality standards, conduct research, cooperate with other appropriate agencies, encourage voluntary adoption of good air pollution practices, conduct programs of air pollution control education, supply technical assistance, and develop a comprehensive plan for the control of air pollution in the State. Penalties and variance procedures are also provided.

New York and New Jersey cooperate in the interstate sanitation commission, which conducts research and field studies on air pollution, aids the State air pollution enforcement agencies, and makes recommendations to the Governors and legislatures.

North Carolina.—The State air hygiene service in the State board of health is authorized to participate in cooperative, educational, and technical assistance activities and to conduct research on air quality standards.

Ohio.—The director of health is authorized to conduct research and educational and cooperative activities relative to air pollution.

A pollution control certificate, granted upon application to and approval by the tax commissioner, exempts all, or any specified part, of the pollution control facility to which it applies from several kinds of State and local taxes.

Oklahoma.—The State department of health is empowered to conduct research, training, and demonstrations relative to air pollution and its control, and to cooperate with the Public Health Service in administering air pollution control programs.

Oregon.—The sanitary authority is directed to develop a comprehensive plan for air pollution control and prevention; to cooperate with appropriate agencies, Federal and others; to conduct programs of research and education; and to establish and enforce rules, regulations, and air quality standards.

Counties and cities are authorized to enact air pollution ordinances, and to act cooperatively for establishing an air pollution program, setting up if they so desire a board empowered to issue and enforce regulations.

Pennsylvania.—The air pollution commission is authorized to adopt rules and regulations for air pollution control, and to adjudicate alleged violations thereof. The department of health is directed to enforce these regulations and also to carry on research, technical assistance, and cooperative and educational

activities. Regional air pollution associations are authorized to act as liaison between the commission and the inhabitants of their regions.

Rhode Island.—State law provides for smoke control in cities of 150,000 or more, and allows it at local option in smaller cities.

South Carolina.—Statute prohibits the emission of untreated gaseous wastes from certain industrial processes in counties containing cities of more than 65,000 inhabitants.

Tennessee.—The air pollution control service in the State department of public health is authorized to cooperate with other air pollution authorities, conduct research, and provide technical assistance to subordinate units.

Utah.—A board of county commissioners is empowered to pass ordinances to control air pollution. The causing of air pollution shall constitute a misdemeanor.

Washington.—Cities, towns, and counties, and districts formed by combinations of these, are authorized to control air pollution within their boundaries by developing and implementing a comprehensive program, including enforcement, research, and cooperative activities. Districts are governed by boards representing their constituent parts, and are supported by county tax contributions. A State air pollution control board, in the department of health, is authorized to approve research and standard development activities which are carried out by the director of health.

West Virginia.—An air pollution control commission is authorized to adopt and enforce regulations, conduct research, give technical assistance, appoint technical advisory councils for various areas of the State, accept money and aid from the Federal Government, and cooperate with it and other appropriate groups and agencies.

Wisconsin.—Counties are empowered to regulate air pollution by prescribing rules and regulations, setting fees for permits, providing for an appeal board, an advisory board, and/or a county department of air pollution control, and prescribing penalties.

Pollution control installations required or recommended by a local governmental body shall be exempt from local taxation for 5 years, if no net income is created by the installations. Also, such property may be amortized on the basis of a 60-month estimated life for purposes of State income taxation.

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